Food Insecurity in Sub-Saharan Africa

New Estimates from Household Expenditure Surveys

Lisa C. Smith
Harold Alderman
Dede Aduayom

RESEARCH REPORT 146
INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
WASHINGTON, D.C.

International Food Policy Research Institute
2033 K Street, N.W.
Washington, D.C. 20006-1002
U.S.A.
Telephone +1-202-862-5600
www.ifpri.org

Library of Congress Cataloging-in-Publication Data

Smith, Lisa C.
Food insecurity in sub-Saharan Africa : new estimates from household expenditure surveys / Lisa C. Smith, Harold Alderman, Dede Aduayom.
p. cm. — (Research report ; 146)
Includes bibliographical references.
ISBN 0-89629-150-2 (alk. paper)
1. Food supply—Africa, Sub-Saharan. I. Alderman, Harold, 1948– II. Aduayom, Dede. III. Title. IV. Series: Research report (International Food Policy Research Institute) ; 146.
HD9017.A3572S65 2006
338.1′967—dc22 2006008740

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Foreword

Reducing food insecurity in the developing world continues to be a major public policy challenge, and one that is complicated by lack of information on the location, severity, and causes of food insecurity. Such information is needed to properly target assistance, evaluate whether progress is achieved, and develop appropriate interventions to help those in need. This research report explores a new method of measuring food insecurity using food data collected as part of household expenditure surveys. Such surveys are routinely undertaken by numerous national governments throughout the developing world, but in the past the resulting food data remained largely unexploited for the purposes of measuring food insecurity.

Using data from 12 Sub-Saharan African countries, this innovative and scholarly research by Lisa Smith, Harold Alderman, and Dede Aduayom demonstrates the value of such data for generating estimates of both diet quantity indicators, such as the share of populations that are food-energy deficient, and diet quality indicators, such as diet diversity.

While the approach does not permit an annual update of the food security situation due to the time-consuming nature of household surveys, the results indicate that household expenditure surveys are a rich source of data for improving food security measurement. The approach facilitates an improved understanding of benchmarking and progress toward the United Nations' Millennium Development Goal of halving the proportion of people suffering from hunger by 2015, and similarly of the much-preferred World Food Summit Goal of actually cutting the absolute number of undernourished people in half by that time. We hope that updates to these household-based data sources are done, at minimum, on a five-year basis to enrich the understanding of progress in food security, or the lack thereof.

Joachim von Braun
Director General, IFPRI

Acknowledgments

Funding for this research has been generously provided by the Australian Agency for International Development, the Canadian International Development Agency, the Department for International Development of the United Kingdom, the United States Agency for International Development's Presidential Initiative to End Hunger in Africa, the United States Department of Agriculture, and the World Bank.

The Africa Household Survey Databank of the World Bank, which facilitated access to many of the data sets, and especially the ready assistance of Pascal Heus and Christopher Rockmore are gratefully acknowledged.

The following government statistical services administered the surveys and compiled the data sets used in this study:

- Institut de Statistiques et d'Etudes Economiques du Burundi
- Central Statistical Authority of Ethiopia
- Ghana Statistical Service
- Direction Nationale de la Statistique, Republique de Guinee
- Central Bureau of Statistics of Kenya
- National Statistical Office of Malawi
- Instituto Nacional de Estatistica de Mozambique
- Direction de la Statistique de Rwanda
- Direction de la Prévision et de la Statistique de Senegal
- National Bureau of Statistics of Tanzania
- Uganda Bureau of Statistics
- Central Statistical Office of Zambia

We thank the staff members of these organizations who helped to answer our questions and find additional data needed to undertake the analysis.

We would like to especially acknowledge Lawrence Haddad for his role in instigating this research program, his continual strong support throughout, and his technical contributions.

Elizabeth Byron, Timothy Frankenberger, Joachim Von Braun, Doris Wiesmann, two anonymous referees, and the Socio-Economic Statistics and Analysis Service of the Statistics Division of FAO gave valuable comments on the manuscript. We also appreciate the comments and feedback of participants at presentations made at IFPRI, FAO, and the FIVIMS International Scientific Conference on Food Deprivation and Undernutrition in June 2002.

This research required a great deal of data processing, computer programming, investigative inquiry, and travel to many of the study countries. Doris Wiesmann, Ibrahima Wane, Ali Subandoro, Arif Rashid, Ellen Payongayong, Aida Ndaiye, Smita Ghosh, Elizabeth Byron, and Joshua Ariga are thanked for their assistance with these tasks.

The findings, interpretations, and conclusions expressed in this report are entirely those of the authors. They do not necessarily represent the view of the World Bank, its executive directors, or the countries they represent, or of IFPRI and its supporting organizations.

Summary

Hunger is a pervasive problem in developing countries, undermining people's health, productivity, and often their very survival. Therefore, much of the development agenda focuses on directing scarce resources to providing food to people in need or enabling them to acquire it themselves. The foundation for doing so is a reliable information base on food insecurity—that is, access by people to food—which is the most immediate cause of hunger. Such information is fundamental to effectively targeting assistance, evaluating progress, and developing interventions. Its need is now more urgent than ever as efforts are stepped up to meet the Millennium Development Goal (MDG) of halving the proportion of people who suffer from hunger by 2015. Yet arriving at an accurate measure of food insecurity that is comparable both within and across countries remains a challenge. The indicator most widely employed by policymakers is the measure of "undernourishment," or the percentage of a country's population that does not consume sufficient dietary energy, by the Food and Agriculture Organization of the United Nations (FAO). This method is based on a country's food supplies rather than directly on data representing peoples' access to food. Given a lack of data collected at the household or individual level in national surveys, this is the only feasible method at present, though its reliability for policymaking and program planning has been the subject of considerable debate.

This report introduces new estimates of food insecurity based on food acquisition data collected directly from households as part of national household expenditure surveys (HESs) conducted in 12 Sub-Saharan African countries. The report has three objectives: (1) to explore the extent and location of food insecurity across and within the countries; (2) to investigate the scientific merit of using the food data collected in HESs to measure food insecurity; and (3) to compare food insecurity estimates generated using HES data with those reported by FAO and explore the reasons for differences between the two. The overall purpose is to investigate how the data collected in HESs can be used to improve the accuracy of FAO's estimates, which are being used to monitor the MDG hunger goal. The study is based on both diet quantity and diet quality indicators of food insecurity. The two main indicators of focus are the share of people consuming insufficient dietary energy, or the prevalence of "food energy deficiency" and the share of households with low diet diversity. The study finds these to be valid indicators of food insecurity and to be reasonably reliably measured. They are also comparable across the study countries despite differing methods of data collection.

This report confirms that food insecurity is a major problem in Sub-Saharan Africa. The prevalences of food energy deficiency among the study countries range from 37 percent (Uganda) to 76 percent (Ethiopia). Problems of diet quality associated with the region's high rates of micronutrient deficiencies are found to be widespread. Notably, there is no strong association between the diet quantity and diet quality measures. If both of these aspects of food insecurity are taken into account, country rankings differ substantially from results considering diet quantity alone, which is the convention.

HESs offer a rich lens through which to examine food insecurity within countries as well. The socioeconomic characteristics examined here—region of residence, urban or rural resi-

dence, economic status, and female- or male-headed household—are only a few of particular interest to policymakers. The study countries display wide variation in the characteristics, with the only consistent patterns emerging being that male-headed households in eastern and southern Africa and urbanites have a clear advantage when it comes to diet quality. As expected, income has a potent bearing on food insecurity.

The study identified strong differences between HES and FAO estimates of food energy deficiency for the 12 study countries, resulting in significantly different pictures of the magnitude of food insecurity in the countries and country rankings. The main source of the divergences lies in differences in the national-level parameters used to generate the FAO estimates (mean energy availability, energy requirement, and distribution across households) rather than in the method itself. The lower requirement used explains why FAO estimates are almost uniformly lower than those reported here. Nevertheless, the most important factor behind the divergence between the FAO and HES estimates is not found there but in the differences in the underlying estimates of national energy availability.

HES estimates of food energy deficiency are found to be more strongly associated with other MDG indicators of poverty and hunger than are the FAO estimates. The correlation between HES country rankings and poverty is 3.6 times higher than that for the FAO estimates. The same correlation for estimates of child malnutrition is 1.7 times higher. The HES estimates are also more consistent with country rankings based on a survey of expert opinion. These findings provide empirical support that HES data are a useful source of information for improving the accuracy of FAO estimates of food insecurity.

The main advantage of using HES data for measuring food insecurity is that they are a source of multiple, policy-relevant, and reasonably reliable measures. They allow multilevel monitoring and evaluation, including that of within-country and national food insecurity and, given data from a sufficient number of countries, of regional and developing-world food insecurity as well. Their main disadvantage is that data are not collected for all countries regularly, partly because of the financial resources and skill levels required for data collection, processing, and analysis. Creating a database of cross-country comparable estimates of food insecurity based soundly on household-level data, while currently not feasible, is fast becoming a reality as the surge in the collection of HESs that began in the 1990s continues.

Meanwhile, HES data can be used to improve the accuracy of the FAO's estimates in a number of ways: first, they can improve estimates of national food supplies; second, they can improve the accuracy of estimates of the distribution of dietary energy across countries' populations and increase the number of countries for which they are available; and, finally, HES-derived estimates of food energy deficiency can continue to serve as a reference for comparison and validation. The above endeavors require that this report's analysis be extended to the other developing regions, providing the essential data for (1) improving estimates of energy availabilities and their distribution and (2) generating regional and developing-world estimates of food insecurity using FAO or alternative methods. Additionally, basic research is needed to resolve outstanding reliability issues in the estimation of food energy deficiency and poor diet quality from HESs. Finally, because many HESs are not undertaken with the intention of calculating measures of food insecurity, they often do not contain the appropriate data for doing so. To remedy this problem, guidelines containing best practices for collecting and processing HES food data are needed.

CHAPTER 1

Introduction

Food is the most basic of human needs for survival, health, and productivity. It is thus the foundation for human and economic development. As is now well known, enough food and much more is produced to meet the needs of all people in the world today. Hunger nevertheless remains a pervasive problem in developing countries, and much of the development agenda must focus scarce resources on either providing food to people in need or enabling them to acquire it themselves. The foundation for doing so is a reliable information base on "food insecurity"—the most immediate cause of hunger[1]—which is needed for answering some essential questions:

- Where are the world's hungry?
- How many people are hungry?
- How is hunger changing over time?
- What are the causes of hunger?

In turn, the answers to these questions are essential for targeting assistance, evaluating whether progress is being achieved, and developing appropriate policies and programs for helping people. Knowing these answers is urgent given the undoubtedly large numbers of people affected, including 148 million developing country children under 5 who are stunted. It has become even more urgent as efforts are stepped up to meet the Millennium Development Goal (MDG) of halving the proportion of people who suffer from hunger by 2015.

Although there is now general agreement on what food insecurity is—that is, a phenomenon of *access* by people to food rather than only the availability of food in a country—arriving at an accurate measure of it that is comparable both within and across countries remains a challenge. Currently existing methods of measuring food insecurity suffer from a number of limitations.

The methods most widely employed for cross-country comparisons are based on national aggregate data on food availability or income rather than directly on data representing peoples' access to food. These are at present the only feasible methods because of a lack of sufficient food data collected at the household or individual level in nationally representative surveys. The method most widely cited and employed by policymakers is the United Nations Food and Agriculture Organization (FAO) measure of "undernourishment," a measure of the percentage of countries' populations that does not have access to sufficient dietary energy

[1]It is important to note that "hunger" and "food insecurity" are distinct concepts. Whereas food insecurity refers to lack of access to food, hunger is "an uneasy sensation, exhausted condition, caused by want of food" (*Oxford English Dictionary*).

(Naiken 2003). It is based on national food supply data. The United States Department of Agriculture (USDA) reports estimates of the same measure based on countries' national incomes along with food supplies (Shapouri and Rosen 1999; Senauer and Sur 2001).

Although these methods yield estimates that are useful advocacy tools for reducing hunger and may capture broad regional differences and trends, their reliability for policymaking and program planning, particularly that of FAO's country estimates, has been the subject of considerable debate (Naiken [cited in Smith 1998b]; Smith 1998a; Svedberg 2000; Gabbert and Weikard 2001; Haddad 2001; Aduayom and Smith 2003; Broca 2003; David 2003; Senauer 2003; Svedberg 2003). There are large discrepancies between the FAO and USDA estimates of the prevalence of food energy deficiency at even the level of the developing-country regions. For example, the FAO estimate of the prevalence for Sub-Saharan Africa was 34 percent in 1997–1999 (FAO 2001). That reported by USDA for the same period was 50 percent (Shapouri and Rosen 1999). The difference in the estimates for Latin America and the Caribbean is even higher, with FAO reporting 11 percent and USDA reporting 40 percent. These discrepancies send conflicting messages to policymakers hoping to efficiently target resources toward reducing food insecurity.

For the practical purposes of food security policy decisionmaking, the methods based on aggregate food availabilities and incomes have three further limitations: (1) they cannot be used for determining the location of food insecurity within countries;[2] (2) they have limited use for understanding the causes of food insecurity; and (3) they focus only on diet quantity to the exclusion of other important aspects of food security, such as diet quality and vulnerability (Smith 2003).

Two alternative measures that are based on household survey data are considered to be reliable but do not measure valid indicators of food insecurity. Height and weight data collected using anthropometric methods are the basis for a measure of "undernutrition," which is influenced not only by food consumption but also by health status (Shetty 2003). Poverty or "livelihood insecurity" measures capture people's ability to satisfy a number of different basic needs, among which tight trade-offs may be faced, not just food (Frankenberger et al. 1997).

Two final methods of measuring food security are considered to be reliable and based on valid indicators but suffer from some practical constraints. The first measures nutrient adequacy from data collected on individual or household food intake, usually over the previous 24 hours. This method is far too costly to implement on a national scale for most countries (Ferro-Luzzi 2003; Swindale and Ohri-Vachaspati 2004). The second uses qualitative measures to capture people's own perceptions of the extent to which they suffer from hunger. Although more research is needed, this method has limited usefulness for cross-country comparisons because surveys must be adapted to local circumstances (Kennedy 2003).

The purpose of this report is to introduce new estimates of food insecurity based on food data collected directly from households as part of national household expenditure surveys (HESs). In these surveys, households are asked to report the quantities of or expenditures on foods they acquired in

[2] With respect specifically to the FAO measure, food supply data are not used to estimate subnational differences in food availability and deficiency because, as stated in Naiken (2003), "it is not possible to disaggregate the national estimate by subnational areas as the food balance sheet approach is not applicable at the subnational level" (page 25). Presumably this is because the approach relies on imports and exports of food to determine how much food is available in a country, and only production data are collected for subnational regions.

the recent past, commonly the last 1 or 2 weeks. They are asked about their food purchases, the food they consume from their own fields or gardens, and, usually, food received in kind as well. The data, when complemented by metric weights of food reported in local units of measure or metric food prices, allow estimation of quantities of food acquired by households. These can then be used to calculate a number of measures of food security and insecurity at national and subnational levels. The data allow determination of whether a household has acquired sufficient food to meet its members' energy requirements in addition to calculation of measures of diet quality, an equally important aspect of food security.

Over the 1990s and continuing into the present, there has been a surge in the collection of national HESs, whether by government statistical services or through the World Bank's Living Standards Measurement Survey program or its associated regional programs. HESs are becoming more and more routinely collected and used as part of the information base for policy decisions by governments and international development agencies. Thus, creating a cross-country comparable global food security database founded on them, although currently not feasible, is fast becoming a reality.

The report focuses on the developing country region that is considered to have the most severe food insecurity, Sub-Saharan Africa. Many countries in the region are not even able to meet the food needs of their populations at the aggregate, national level, much less ensure that sufficient food reaches all people (Smith et al. 1999). One-quarter of all preschool children in the region were underweight, and one-third stunted, in 2000 (ACC/SCN 2004). Poor diet quality is a serious problem. Forty-three percent of the region's people, including the same percentage of school-age children, suffer from iodine deficiency, the primary cause of preventable mental retardation in children. About one-third of all preschool children have a dietary deficiency of vitamin A, an essential micronutrient for normal functioning of the visual system, growth and development, immune function, and reproduction (ACC/SCN 2004). Further, the population affected by goiter as a result of iodine deficiency is 20 percent, the highest in the developing world (ACC/SCN 2000).

The report has three objectives. The first is to explore the location and extent of food insecurity across and within 12 Sub-Saharan African countries with HESs conducted in the 1990s. The countries are Burundi, Ethiopia, Ghana, Guinea, Kenya, Malawi, Mozambique, Rwanda, Senegal, Tanzania, Uganda, and Zambia. The second is to explore the scientific merit of using HESs to measure food insecurity, taking a look at the validity of the measures that can be estimated, the reliability of the methods for doing so, and international comparability. The third is to compare the food energy deficiency estimates generated from HES data with FAO's undernourishment estimates and begin to explore the reasons for any differences between the two. The ultimate aim is to look for ways to improve the accuracy of FAO's estimates, which are being used to monitor progress toward reaching the Millennium Development Goal on hunger.

The report is organized as follows. Chapter 2 describes the indicators of food security used in this study and discusses measurement issues. Chapter 3 presents the data sets employed and lays out the methodology for calculating the measures. Chapter 4 reports the estimates of food insecurity, comparing population groups both across and within countries. In Chapter 5, the estimates of national food energy deficiency prevalence are compared with those reported by FAO, and some reasons for the differences are explored. Chapter 6 presents evidence on comparability of the estimates across countries and some other reliability issues. Chapter 7 concludes with a summary of the findings and a discussion of how HESs can help improve the reliability of global food insecurity estimates.

CHAPTER 2

Conceptual and Empirical Basis for Measures of Food Insecurity

This chapter first describes the indicators of food security used in the report and their measures. Following this, the conceptual validity of the indicators, that is, how well they conform to the definition of food security given, is discussed. Next, the reliability of the measures is addressed. Are we accurately capturing the measures with the data and the method of calculation used? Finally the issue of comparability across countries of the measures is taken up.

Food Security Indicators and Their Measures

The four indicators of food security (and insecurity) employed in this report, along with a description of how they are measured at the household level, are listed in Table 2.1.

The first two are indicators of diet *quantity,* the amount of food eaten by people. The first is average household food energy availability per person. It is measured as the amount of energy in the food acquired by the household over the survey reference period divided by the number of household members and days in the period. The data collected from households in HESs are either (1) expenditures on each food or (2) quantities acquired of them, which are often reported in nonmetric or "local" units of measure, for example, bunches or cans. The first essential step in calculating this measure is to convert the data to metric quantities (grams or kilograms). To do this, reported expenditures on each food are divided by the food's metric price; reported quantities in local units of measure are multiplied by the food's metric weight. The energy content of the food acquired can then be determined using food composition tables.

The second diet quantity indicator is the percentage of people in a population group who do not consume sufficient dietary energy. It is measured by determining whether a person lives in a household that acquires sufficient food over the survey reference period to meet the dietary energy requirement of all of its members. The total energy in the food that the household acquires is compared to the sum of the daily energy requirements of each of its members. The requirements employed are for basal metabolic function (a state of complete rest) and light activity, such as sitting and standing.

The next two indicators, household diet diversity and the percentage of households with "low diet diversity," are indicators of diet *quality.* Diet diversity indicates how varied the food a household consumes is. Based on the quantity or expenditure data collected from households, it is calculated by counting the number of food groups, out of seven (see Table 2.1), from which food is acquired over the survey reference period. The percentage of households with low diet diversity is measured by determining whether a household fails to acquire at least one food from four of the seven groups over the reference period.

Table 2.1 Indicators of food security employed and their measures

Population-level indicator	Household-level measure
Diet quantity	
Food energy availability per capita	Household daily food energy availability per capita. The energy in the food acquired by a household over the survey reference period divided by the number of household members and the number of days in the period.
Percentage of people who are food energy deficient	Whether a household is food energy deficient. Whether a household acquires insufficient food over the reference period to meet the energy requirements for basal metabolic function and light activity of all of its members. (Note: An individual's energy deficiency situation is defined to be that of her or his household)
Diet quality	
Average household dietary diversity	Household diet diversity. The number of food groups, out of seven, from which food is acquired by a household over the reference period. The food groups are: (1) cereals, roots and tubers (2) pulses and legumes (3) dairy products (4) meats, fish and seafood, and eggs (5) oils and fats (6) fruits (7) vegetables
Percentage of households with low diet diversity	Whether a household has low diet diversity. Whether the household does not acquire at least one food from four of the above seven groups over the reference period.

Validity of the Indicators

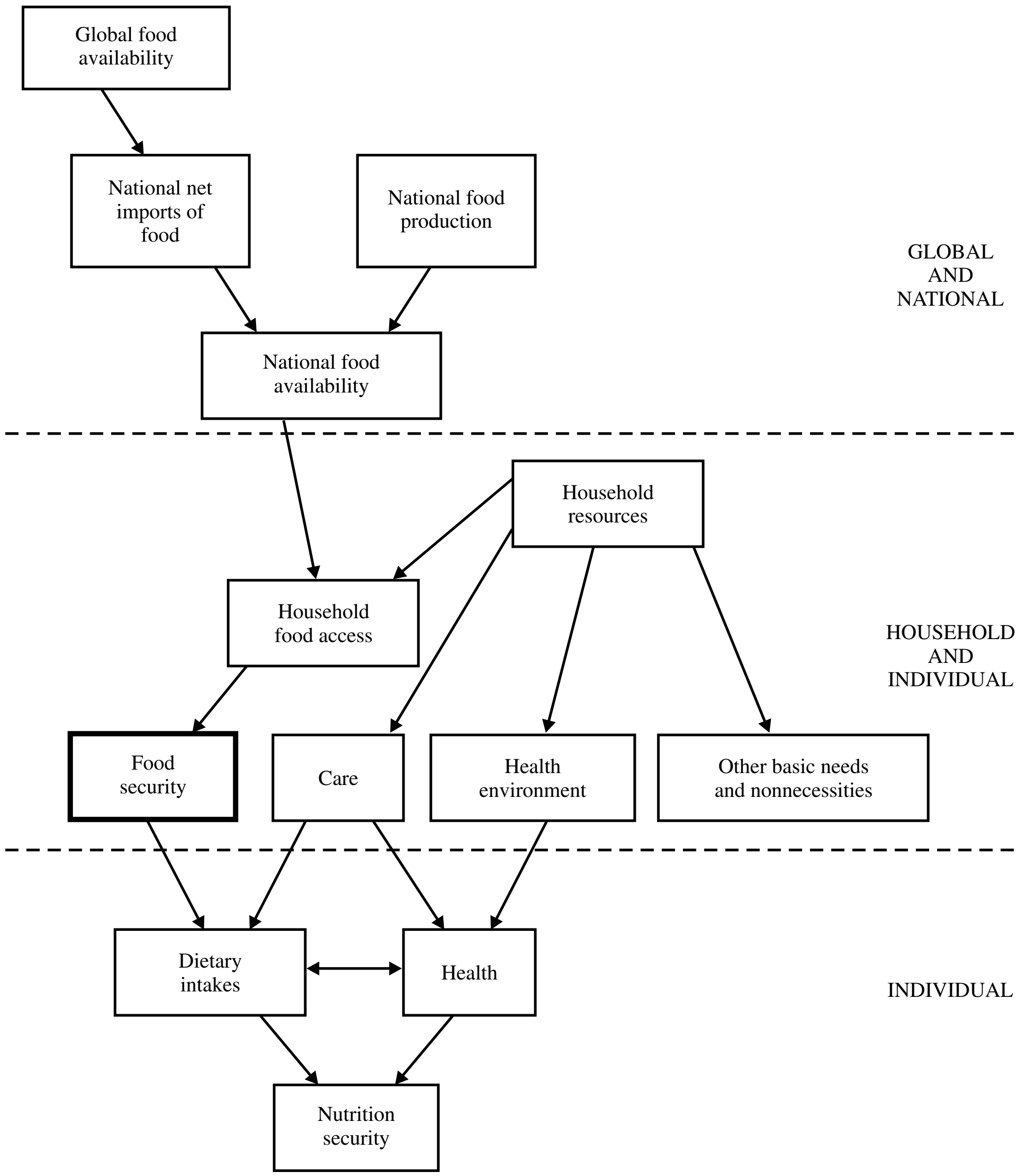
The definition of food security used in the report is:

> Food security . . . [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (Adopted at the 1996 World Food Summit)

Conceptually, how close are the indicators to the definition of food security? Are they conceptually distinct from the major factors that determine food security and those that food security determines? To judge such "content validity" (Trochim 2001) requires not only a firm definition of food security but also a strong conceptual framework for it.

Figure 2.1 gives a conceptual framework for food and nutrition security. It shows how global and national food availability work through peoples' food security to ultimately influence their nutrition security, which is maintenance of a physiological state of nutritional health on a sustainable basis. As is well known, enough food available at global and national levels is necessary for households to have access to food, but it is not sufficient. Households must also have the necessary resources to acquire that food and at the same time meet other basic needs. Finally, food security works through people's dietary intakes to influence their nutrition security. But food security alone is

Figure 2.1 Conceptual framework for food and nutrition security



Source: Adapted from Frankenberger et al. (1997) and UNICEF (1998).

not sufficient for achieving nutrition security. People also need adequate care[3] and a healthy living environment to be able to absorb the nutrients in food and thus use it in their everyday lives (Frankenberger et al. 1997; UNICEF 1998).

Household food energy availability and the percentage of people who are food energy deficient, the diet quantity indicators of food security, are closely related to the notion of access to food by people. Energy from food is arguably the most important nutrient

[3]Care is defined as "the provision in households and communities of time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members" (ICN 1992).

for survival, physical activity, and health, and households are the units through which people generally access food. The indicators pertain to the amount and sufficiency of energy in the food that is immediately available to households for consumption, which is a clear indication of their ability to access sufficient food.

Importantly, the indicators are clearly distinct from indicators of related concepts. They are obviously distinct from national (or even local) food availability, which is a determinant of food security. They are also distinct from indicators of household resource holdings, such as poverty, which captures households' abilities to meet all of their needs, not just food. Finally, they are distinct from nutrition security, which food security determines, but not alone. Thus, from a conceptual standpoint, the two indicators of diet quantity derived from HESs are valid indicators of food security.

In regard to the diet quality indicators—household diet diversity and the percentage of households with low diet diversity—it is well known that energy is not the only nutrient people need to lead active, healthy lives. It is quite possible for a person to meet her or his energy requirement but to be prevented from achieving full physical and intellectual potential as a result of deficiencies of other nutrients, specifically protein and micronutrients such as iron, vitamin A, and iodine (Welch 2004). It is increasingly recognized that inadequate diet quality, rather than sufficient energy consumption, is becoming the main dietary constraint facing poor populations (Ruel et al. 2003; Graham, Welch, and Bouis 2004). Further, a number of studies have documented that improved diet quality as indicated by a more varied diet is associated with improved birth weight and child anthropometric status and with reduced mortality (Ruel 2002, 2003). Thus, it is important that indicators of the nutritional quality of the food people eat be included in any analysis of food security. Like the indicators of diet quantity, the diet quality indicators are conceptually distinct from their determinants (food availability and household resources) and outcomes (nutrition security).

In sum, the food security indicators employed in this report have strong conceptual validity. They cover important aspects of the definition—access, sufficiency, and quality—and capture these aspects well. They do not fully conform to the definition, however, for the following reasons. First, a complete picture of the state of food security should cover an important aspect of its definition that the four indicators do not address: vulnerability to food deprivation in the future (Maxwell and Frankenberger 1992). The indicators do not indicate whether people have access to food *at all times.* Second, the definition of food security stresses that *all* people have access to food. Yet the food data collected in household expenditure surveys indicate access to food of households, not individuals within them.[4] It is now well known that intrahousehold food distribution is not always such that all household members receive the food that they need even if sufficient food is available at the household level (Haddad and Kanbur 1990). Finally, the indicator set does not address issues of food safety and food preferences.

Reliability of the Measures

One of the main advantages of using household expenditure surveys (HESs) to measure food security is that the source of the food data collected is the people (adult women or men) living in surveyed households. The information comes directly from the location in which behavior regarding food consumption

[4]Vasdekis, Stylianou, and Naska (2001) propose a methodology to estimate age- and gender-specific food availability using the household-level data collected in household expenditure surveys that may be useful for future analyses.

takes place and from the people consuming the food. Further, compared to data on other measures of households' resource holdings, such as income and assets, food expenditures data are not especially sensitive; people generally have little incentive to misreport how much food they acquire over a short period of time.[5] Although they may be employed to measure food insecurity for broad geographic areas, the food data collected reflect the food acquired by a household rather than by groups of households in these broader areas, for example, countries or regions within them. Systematic, scientific sampling is the norm, yielding samples that are, for the most part, nationally representative.[6] Although, as discussed below, many types of error can affect estimates of food security, it is these traits that give confidence that gross errors in estimates of food insecurity derived from HESs are avoided.

Quantities of Food Acquired

All four measures described above are based on the data collected on households' acquisition of food. The most common method of data collection is the personal interview in which an enumerator asks one or more household members to recall quantities acquired and/or expenditures made over the "reference period" for food data collection. This period is the total amount of time for which food data are collected, commonly 1 or 2 weeks. The diary method may be employed for households with a literate member. To take into account seasonal variation in food consumption associated with the agricultural cycle, data may be collected either in multiple rounds throughout a year or in one-time interviews conducted randomly across groups of households throughout a year (see more on the implications of this choice below).

A number of nonsampling errors in the measurement of household food acquisition arise during the collection and preparation of HES data. The first is that data collection is plagued by the typical reporting biases and recording errors faced by all household surveys. Respondents may become tired or despondent because they are overwhelmed by the length of the survey or the number of items covered. They may change their normal food acquisition behavior as a result of being included in the survey ("conditioning effects") (Deaton and Grosh 2000). Further, the enumerator may cause the respondent to report incorrectly by asking vague or "leading" questions. He or she may also record the respondent's response to questions incorrectly on the questionnaire or with handwriting that cannot be read by data entry operators. And of course, data entry operators may enter the data incorrectly.

Two important types of systematic bias may arise because respondents have difficulty remembering the food their household acquired over the survey recall period. The first, known as "recall bias," is that respondents may have difficulty remembering their food acquisition over the period itself, resulting in a downward bias. The second is bias as a result of "telescoping," where a respondent may include events that occurred before the recall period, thus inflating estimates of household food acquisition. The shorter the recall period, the more likely is telescoping; the longer the recall period, the more likely is recall bias. In the specific case of food acquisitions, which are of high fre-

[5] There are exceptions, however. For example, households may falsely report a larger than true expenditure on a high-prestige food (such as meat) or understate foods acquired in the belief that food aid may be forthcoming following the survey. These kinds of misreporting are likely to be less of a problem in household expenditure surveys, in which data are collected on a large number of subjects, than in specialized household food consumption surveys.

[6] Population groups that are left out of the censuses that serve as sampling frames are migrants, homeless people, and people living in institutions. Sometimes people living in areas with violence related to conflict or that are otherwise physically inaccessible may also be left out.

quency and small size compared to nonfood acquisitions, recall bias is thought to be more of a problem than telescoping (Deaton and Grosh 2000).

Another area where errors can arise is in the conversion of the data collected on expenditures or quantities to their metric equivalents. If expenditures are collected, they must be divided by metric prices of foods. Obviously, the prices used should represent those faced by the household at the time of the purchase or, in the case of a home-produced food, if it were to buy or sell the food. But this information is not usually collected in HESs, and estimated prices must be used as proxies. They may be estimated as median unit values from households located in the immediate vicinity or even the administrative region, or they may be collected in a price survey administered at the community level or at a broader regional level. However, in the case of price surveys, it may be difficult for a survey team to replicate the kind of transaction that a household itself would engage in. Prices faced may vary even among households that purchase from the same source due to different negotiating abilities or personal connections. Further, richer households may buy higher-quality products that have higher prices (Deaton and Grosh 2000).

Data collected on the physical quantities of foods, rather than expenditures, may be more accurate if foods are weighed using scales on the spot or, for packaged foods, the weight is recorded directly from containers in which they are acquired. However, this technique is rare because it is so time consuming. Further, if the acquired food has already been consumed, it is no longer possible to physically observe and measure it. In most surveys, households report quantities acquired from memory and in nonstandard units with imprecise weights. The collection or estimation of corresponding metric weights of local units of measure appropriate to individual households can present as many challenges as the collection or estimation of accurate metric prices.

The reliability issues are somewhat different when it comes to home-produced foods. The respondent is asked how much of each potentially home-produced food has *been* consumed. Thus all food acquired from this source is not directly observable, and the respondent must always resort to memory. Further, in the reporting of expenditures, the respondent is asked a hypothetical question because, by definition, home-produced foods have not actually passed through the market and been sold or purchased (Deaton and Grosh 2000).

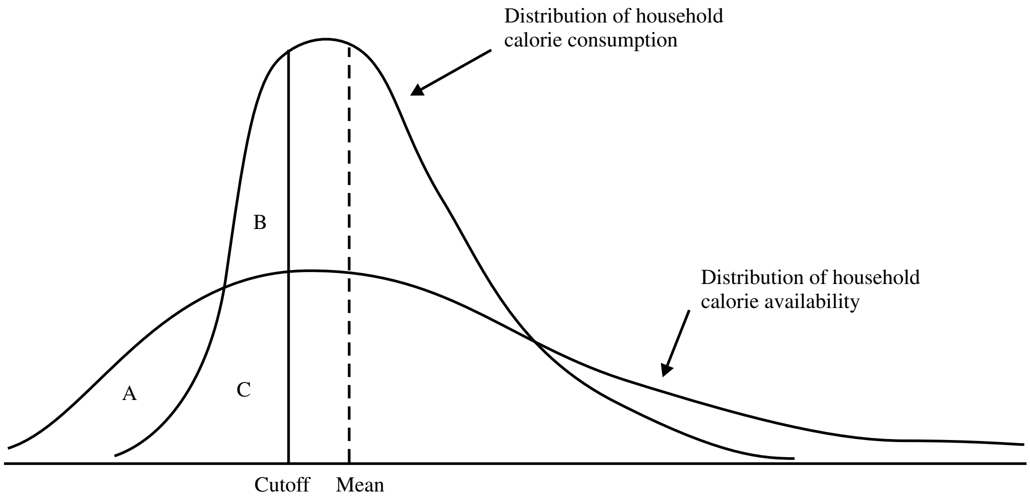
A further reliability concern arises from the fact that information on food purchased and consumed away from home, for example restaurant meals, is usually reported as one lump sum expenditure, with no information collected about the actual identity or quantity of the foods consumed. This obviously hampers conversion to energy content. The practical solution to this problem is to convert using calorie values per unit of expenditure on foods eaten at home (for example, China 1992). Yet people may eat different kinds of food having different calorie values in the meals they consume outside of their homes compared to inside (Rimmer 2001). Further, the relative caloric density of in-home and out-of-home food consumed may differ across income groups, leading to systematically biased estimates. This issue certainly affects the diet quantity measures but also has implications for the reliability of the diet quality measures as meals eaten out of the home may contain food from a wider variety of food groups than those eaten in (see further discussion below).

The Prevalence of Food Energy Deficiency

A number of additional reliability issues with the use of HESs pertain specifically to the measurement of the percentage of people who are not meeting their energy requirements.

The first has to do with the fact that data for all food sources except home production

Figure 2.2 Comparison of probability distributions of household calorie availability and consumption: A hypothetical example



are collected on food *acquired* (purchased or obtained in-kind) rather than *consumed.* Because most foods are perishable and consumed with high frequency, and people try to smoothe their consumption of food over time, we would expect their acquisitions to match fairly well with consumption, even over a short time period. However, some foods, such as some grains, are not perishable and can be stored. Thus, over any given time period, there will be households that are drawing down stocks acquired before the period in order to meet current consumption; there will also be households that are accumulating stocks that will be consumed after the period. This leads to an "availability–consumption" gap, and greater variability in household calorie availability (measured using food acquisition data) than in household calorie consumption, as illustrated using the hypothetical example in Figure 2.2.

Because households in a large population group are equally likely to be drawing down on food stocks as they are to be accumulating them, any availability–consumption gap at the household level represents random error, and estimates of population mean household calorie consumption are unbiased. Thus, as illustrated in Figure 2.2, the mean of the probability distribution of household calorie consumption should theoretically be the same as that of household calorie availability.

Table 2.2 gives some empirical evidence, comparing means of daily per capita energy availability and energy consumption (often referred to as "intake") from three of the few surveys ever conducted in which both food availability and food consumption data were collected from the same households. These surveys, conducted by the International Food Policy Research Institute (IFPRI), were subnational and, for Kenya and the Philippines, administered to relatively poor populations within the countries. The data on the availability of foods were collected for a 1-week period, whereas those on food consumption were collected for the previous 24-hour period. For all three surveys, the sample means of energy availability and consumption are very close. The greatest difference is for Kenya, for which availability is 4.6 percent lower than consumption.[7]

[7]Extensive research comparing the availability (measured using HESs) and intakes (measured using 24-hour recall dietary intake surveys) of various foods and food groups has been undertaken as part of the DAFNE (Data

Table 2.2 Comparison of daily per capita energy availability and consumption for subnational samples from Kenya, the Philippines, and Bangladesh

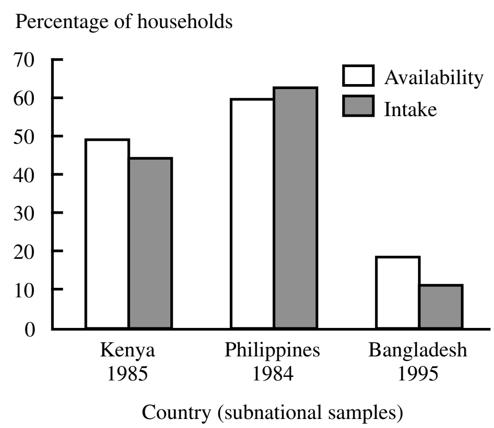
Country and quartile	Energy availability (kcal)	Energy consumption (kcal)	Percentage difference	Number of households
Kenya (1985–87)	1,884	1,978	–4.6	1,161
Philippines (1984–85)	1,909	1,959	–2.6	1,792
Bangladesh (1995–96)	2,313	2,285	1.2	943

Source: Smith (2003), Table 1.
Note: The numbers from Kenya and the Philippines were originally reported in Bouis, Haddad, and Kennedy (1992). Those for Bangladesh were calculated by the authors from raw data collected under the "Commercial Vegetable and Polyculture Fish Production in Bangladesh" project (Bouis et al. 1998).

When it comes to estimates of food energy *deficiency,* however, the lack of bias illustrated above does not necessarily apply. Increased variability in food acquisition data compared to consumption can theoretically lead to different estimates of food energy deficiency depending on which data source is used. In particular, if the population energy requirement is below the mode of the energy availability distribution, estimates of the prevalence of food energy deficiency are biased upward and vice versa (Deaton and Grosh 2000).

The data from Kenya, the Philippines, and Bangladesh give evidence that this source of bias in estimates of food energy deficiency estimated from HES data is not a major issue, as shown in Figure 2.3. In the Sub-Saharan African country Kenya, a relatively low correlation between household-level estimates of energy availability derived from food acquisition and food consumption data is found (0.37, as reported in Lence 2003). This is consistent with the expected availability–consumption gap associated with the accumulation and drawing down of food stocks. The standard deviation of the availability estimate is higher than that of the consumption estimate, by 4 percent, indicating higher variability in the former. Nevertheless, there is little difference in the estimates of food energy deficiency derived from the two sources, 48.8 percent versus 44.2 percent. In the theoretical example in Figure 2.2, this would be the case if the area (A+C) were equal to the area (B+C), that is, if A=B. Note that the existence of, magnitude, and direction of this bias need to be investigated further using national samples, which contain less homogeneous populations.

Figure 2.3 Comparison of the percentage of food-energy-deficient households estimated using energy availability and intake data from Kenya, the Philippines, and Bangladesh (subnational samples)



Source: Smith (2003).

Food Networking: Network for the pan-European food data bank based on household budget survey data) project (see Becker 2001; Naska et al. 2001; Naska, Vasdekis, and Trichopoulou 2001).

A second reliability concern pertains to the fact that although most of the food acquired by a household is eventually consumed by its members, some of it may be wasted or given to pets or guests. Data on the latter are generally not collected in HESs. Thus, for a population group, energy availability will systematically overestimate energy consumption, leading to a downward bias in estimates of food energy deficiency. Overestimation of energy availability is greater for the rich, who are more likely to waste food or give it to pets or guests than the poor (Bouis, Haddad, and Kennedy 1992; Bouis 1994). To illustrate again using the data from Kenya, the Philippines, and Bangladesh, Table 2.3 shows considerable differences between energy availability and consumption for the first and fourth per capita total expenditure quartiles. This issue must be taken into account in analysis of the relationship between income and food energy deficiency, as will be undertaken in Chapter 4 of this report.

A third reliability concern in the estimation of food energy deficiency arises from the use of reference periods[8] for food data collection that are shorter than 1 year, the period for which estimates are desired. In the typical survey, data are collected using single visit interviews and a 1-week, 2-week, or 1-month reference period. This is not a problem if the objective is to obtain an unbiased estimate of mean household energy consumption over a year's time, in which case short reference periods along with short recall periods are desired to overcome recall bias (Deaton and Grosh 2000). As mentioned above, the interviews can be conducted randomly across households throughout a year to take into account seasonal variations.

On the other hand, if the objective is to obtain an unbiased estimate of the prevalence of food energy deficiency, as long a reference period as possible should be used in order to eliminate some of the day-to-day randomness in households' food consumption that inflate variation in the data. To attain a year-long reference period, multiple visits over a year with short recall periods can be used. As pointed out by Deaton and Grosh (2000), however (referring to both food and nonfood consumption), "Because consumption is smoothed within the year, measuring it over two weeks or a month may yield a sufficiently accurate picture of annual consumption to make it not worth incurring the cost of adding yet more visits" (p. 116).

There is some evidence that the short reference period problem is not as much of a concern when it comes to foods (as opposed to nonfoods). Food expenditure data from national HESs undertaken in four countries (Cote d'Ivoire, Ghana, Pakistan, and Vietnam) were collected using two reference periods, a 2-week period and a 1-month period. For the latter, households were asked to estimate acquisitions of foods in the "usual month" in which they are acquired, essentially extending the reference period to a year. Means and dispersion of total food expenditures were found to be similar (Deaton and Grosh 2000).

Evidence from an FAO study of the IFPRI surveys mentioned above, however, suggests that measures of dispersion across households in calorie consumption based on single-visit, short reference periods can be significantly higher than those based on multiple visits throughout a year. In addition to Kenya, the Philippines, and Bangladesh, the study included IFPRI surveys from Pakistan and Zambia. The surveys repeated food consumption measurements with 1-day or 1-week recall periods from 3 to 12 times throughout a year. The standard deviations of household calorie consumption per capita attributable to interhousehold variation (based on the average over the multiple visits, i.e., on a year-long reference period)

[8]A reference period for food data collection is the total time for which households' food acquisitions are reported.

Table 2.3 Comparison of daily per capita energy availability and consumption for subnational samples from Kenya, the Philippines, and Bangladesh, by total expenditure quartile

Country and quartile	Energy availability (kcal)	Energy consumption (kcal)	Percentage difference
Kenya (1985–87)			
1	1,441	1,706	–15.5
2	1,759	1,948	–9.7
3	2,043	2,026	0.84
4	2,293	2,232	2.7
Philippines (1984–85)			
1	1,385	1,726	–19.8
2	1,684	1,877	–10.3
3	2,029	2,035	–0.29
4	2,540	2,196	15.7
Bangladesh (1995–96)			
1	1,819	2,101	–13.7
2	2,164	2,270	–4.4
3	2,471	2,346	4.6
4	2,801	2,423	16.2

Source: See Table 2.2.

ranged from 315 to 808 kilocalories. Those attributable to between-round variation (based on single visit, short reference period data) were inflated above these by from 70 to 316 kilocalories (FAO 1996, Appendix 3 Table 4).[9]

A fourth reliability issue in the estimation of food energy deficiency using HESs, a concern applicable to household survey data in general, is that variation in the data is further inflated by the presence of the numerous nonsampling errors listed above (e.g., recall error, data entry error). The effect of increased variability in the data on estimates of food energy deficiency, whether caused by short reference periods or nonsampling errors, is addressed further in Chapter 6 using the study data sets.

A fifth important reliability issue pertains to the energy requirement employed. Actual energy requirements of individuals depend on their age, sex, body size, activity level, and individual physiology, for example, metabolism. To determine the energy needs of a group of individuals, given unknown actual requirements (because of individual variation), the Expert Consultation on Energy and Protein Requirements (FAO/WHO/UNU 1985) recommends the use of average energy requirements for people of different sex and age groups, levels of activity, and, for adults, body size, that apply to all individuals globally. In HESs, data are collected on age and sex but none of the other characteristics.

The "light" activity level is chosen for this study as a normative standard applicable to all populations. As such, a person who does not consume enough food to meet the energy requirement for basal metabolic function and light activity of the average-weight person in his or her age and sex group is considered to be food energy deficient.[10] However, because we do not know

[9]The decomposition of variance contained an additional category, that attributable to a "residual" or "error" effect.

[10]The average weight of men 18 years or older is set at 65 kilograms. That for women is set at 57.5 kilograms (FAO/WHO/UNU 1985, Tables 42–47).

each person's actual requirement (for basal metabolic function and light activity), and in each age and sex group there is actually a range of requirements that may apply to individuals, there will be some classification error. Some people whose actual requirement is below the average might be consuming an energy level below the average requirement but still meeting their own individual requirement. Similarly, some people whose actual requirement is above the average might be consuming an energy level above the requirement but below their own individual requirement. For estimating population prevalences, if these two groups are roughly the same size, the errors cancel each other out (Mason 2003). Whether they are is a subject for future research.

A sixth, related issue is that the international dietary energy requirements recommended in FAO/WHO/UNU (1985) are intended to be applied to population groups. Without knowing an individual's own requirement (based on age, sex, body weights, genetic makeup, etc.), it is inappropriate to use the requirements to judge whether she/he is consuming adequate dietary energy. By inference, it is also inappropriate to judge the energy adequacy of a household using the requirements. Yet in this study they are applied directly at the household level before estimating the percentage of people who are food energy deficient in a country. Some empirical evidence on whether this issue is of major concern is presented in Chapter 6 using the study data sets.

A final issue, mentioned above in the section on indicator validity, is that what is actually being measured is whether the energy availability of a *household* falls below its energy requirement, not whether that available to each member falls below her or his own *individual* requirement. If food is not distributed according to need within households, then there may be some people living in households classified as food energy surplus who are in fact not meeting their requirement. Similarly, there may be some people living in households classified as food energy deficient who are nevertheless meeting their requirements. If these two "error" groups are not of the same size, then there will be inaccuracies in the estimation of the percentage of people who are food energy deficient in a population group.

Diet Diversity and "Low Diet Diversity"

The measurement of diet diversity is simple and straightforward. The particular measure used here is based on the classification system developed by Arimond and Ruel (2004) (with some modification),[11] in which food groups rather than individual foods are used. The first of the seven food groups—cereals, roots, and tubers—contains starchy staples that are the main source of dietary energy. The second through fourth groups—pulses or legumes; dairy products; meat, fish and seafood, and eggs—contain foods that are high in protein. When pulses and legumes are combined in the same meal with cereals, they supply a favorable mixture of essential amino acids. The protein of animal foods is of high biological value. Additionally, animal foods are good sources of micronutrients that are deficient in many people's diets. Examples are calcium (milk and dairy products, some small fish species), easily absorbable iron and zinc (meat, fish, and eggs), and the fat-soluble vitamins A and D (fish liver and fish oil, eggs, fat in milk and dairy products). The fifth group—fats and oils—contains foods that may be good sources of fat-soluble vitamins, and they assist with their absorption. The sixth and seventh groups—fruits and vegetables—contain

[11]The main modification is that Arimond and Ruel's (2004) food groups 5 and 6 are "Vitamin A–rich fruits and vegetables" and "Other fruits and vegetables or fruit juice."

foods that are good sources of micronutrients and fiber. Most vegetables are rich in carotene and vitamin C, and some contain significant amounts of iron and other micronutrients. The main nutritive value of fruits is their content of vitamin C, and some fruits, such as papaya and mango, are also rich in carotene (Latham 1997).

Research to date from both developed and developing countries (including Kenya, Nigeria, Mali, and Mozambique in Sub-Saharan Africa) consistently shows that diet diversity is a good indicator of nutrient adequacy, that is, a diet that meets requirements for energy and all essential nutrients (see review in Ruel 2002). The studies examined a variety of nutrients, including protein, iron, vitamin A, niacin, vitamin C, and zinc. Further, studies from Mali, Vietnam, and the United States indicate that diet diversity indicators based on food groups predict nutrient adequacy better than do those based on individual foods (Ruel 2002). Mitigating concerns that simply counting the number of food groups without taking into account portion size results in an insufficiently precise measure, a study of school-age children in Kenya showed that imposing minimum quantity restrictions did not improve the performance of a diet diversity index (Ruel et al. 2004).

With respect to the low diet diversity measure, there are no international recommendations for optimal food or food-group diversity and thus for determining whether a household or individual has a low-quality diet based only on knowledge of which foods people eat. The diet quality indicators in this study are used for two purposes: (1) to compare diet quality across and within countries and (2) to compare diet quality and diet quantity measures of food insecurity. Proper cutoffs must be based on further research that relates measures of diet diversity to measures of nutrient adequacy in specific populations (Ruel 2002; Arimond and Ruel 2004). Meanwhile, the above purposes are adequately achieved by using the admittedly arbitrary cutoff chosen here of four out of seven food groups.

One reliability issue that arises in the measurement of diet quality using household expenditure surveys is that measures are based only on the foods acquired for consumption inside the home. This is because, as mentioned above, data are generally collected only on the total expenditure on foods eaten out of the home, not on each individual food. The identity of the foods is thus unknown. The diet diversity measure will be biased downward, and the low diet diversity measure biased upward, the greater is the proportion of food acquired outside of the home.

Cross-Country Comparability of the Measures

One of the main goals of this research is to produce national estimates of the four measures of food security that are comparable across countries. However, the data sets used differ from one another in a number of respects, including

1. The recall and reference periods employed
2. The type of food data collected, whether only expenditures or quantities as well, which determines the technique used for conversion to metric quantities
3. The foods for which data are collected, including specificity within groups of foods and total number of foods
4. The means of data collection, whether diary or interview

The implications of 1 and 2 have already been discussed above. The number of foods for which data are collected involves a tradeoff between costs and accuracy. Although greater specificity and detail are thought to lead to greater reporting accuracy, evidence from experiments of surveys in Indonesia, El Salvador, Jamaica, and Ecuador show mixed results. As Deaton and Grosh (2000) point out, drastically short lists of items (for example, 10) are likely to lead to an underestimation of energy consumption, whereas drastically long ones (for example, 3,000) are impractical.[12]

With respect to the means of data collection, an accurately kept diary, where acquisitions of food are recorded immediately after they take place, would eliminate many errors, including recall error and telescoping. However, in practice, diaries cannot be kept unless there is a literate person in the household. If not, which is often the case in developing countries, then the interviewer visits the household frequently to fill in the diary, in which case it is not really a diary but an oral interview. Also, if the diary is not filled out every day, issues of recall bias and telescoping still remain (Deaton and Grosh 2000).

The differences across the data sets used in this study on the above traits raise questions about the comparability of the resulting estimates of food insecurity across countries. This issue is addressed further in Chapter 6 of this report.

[12]Lagiou et al. (2001) discuss methods for ensuring the comparability of foods and food groups across country surveys using the example of European HESs.

CHAPTER 3

Data and Methods

The locations of the study countries are given in Figure 3.1. Three are in West Africa, six in East Africa, and three in southern Africa. This chapter starts by discussing how the countries' data sets were selected. It then lays out the data collection methods, including the specific type of food data collected in each country's survey. Following, the calculations of three underlying measures on which the measures of food security used in the report are based—metric quantities of food, the energy content of foods, and energy requirements—are discussed in detail. In the last section an explanation of the data-cleaning protocol is given.

Selection of Data Sets

The data sets were selected from 76 nationally representative surveys conducted in Sub-Saharan Africa in the 1990s. They were subjected to a thorough review to ensure that they are of good quality and contain appropriate data for the calculation of the measures of food security. The minimum requirements for the selection of data sets were

1. Nationally representative survey of households
2. Data collected for a comprehensive list of at least 30 food items
3. Recall period of 1 month or less
4. Data collected on home-produced food acquired and monetary purchases
5. Complementary data available for converting reported food acquisition data to metric quantities (metric weights or prices)

Some of the 64 excluded data sets (22 percent) satisfied the above criteria but were rejected in favor of a more recent survey for the country. Appendix A contains a list of the countries for which nationally representative HESs were conducted in the 1990s and, for those that were not selected, the main reason(s) why.

The importance of national representativeness (criterion 1) is obvious. Without this attribute the data collected could not be used to calculate national estimates of the food security indicators. The next section describes the method by which households are selected into a sample whose characteristics can be used to extrapolate to a country's population with appropriate statistical corrections for the sampling design.

With respect to criterion 2, the minimum number of food items of 30 was chosen because it was found that the items in surveys with fewer were generally too broad for accurate recall of their acquisition and determination of dietary energy content (for example, "vegetables" or "meats"). Twenty-six (41 percent) of the dropped data sets did not satisfy this criterion.

A recall period less than 1 month was chosen as a criterion because it was felt that any greater period would lead to unacceptable reporting error. The number of dropped data sets that had a longer recall period was 18 (28 percent). In these cases either households were

Figure 3.1 Locations of study countries

asked to estimate the percentage of home-produced foods that were consumed by the household over the last year, or home-produced food consumed could only be estimated as that left over after food sales for the year (the "disappearance" method).

The number of excluded data sets for which data were not collected on consumption of home production was six (9 percent). As is now well known, this source of food acquisition makes up a large portion of the diets of developing country households, particularly rural households, and must be included for an accurate assessment of food insecurity.

The number of surveys excluded that did not meet the final criterion was 10 (16 percent). Household expenditure surveys are often planned with the intent of calculating national and subnational poverty prevalences. For this, only households' expenditures on various food and nonfood items are needed. As mentioned in Chapter 2, without complementary metric prices for converting to metric quantities or concurrent collection of quantities along with factors to translate them into metric units, it is not possible to calculate food-based measures of food security.

The remaining excluded surveys were dropped from this study for a variety of other reasons, the most common being that the data or documentation were inaccessible or incomplete or that information was received indicating that the data contained gross inaccuracies.

Table 3.1 Basic information on the surveys

Country	Year of data collection	Name of survey	Data collection agency	Survey duration (months)	Number of households surveyed
Burundi	1998	Enquête Prioritaire 1998—Etude nationale sur les conditions de vie des populations	Institut de Statistiques et d'Etudes Economiques du Burundi	6	6,668
Ethiopia	1999	Household Income, Consumption and Expenditure Survey 1999/2000	Central Statistical Authority of Ethiopia	12[a]	17,332
Ghana	1998	Ghana Living Standards Survey 4	Ghana Statistical Service	12	6,000
Guinea	1994	Enquête intégrale sur les conditions de vie des ménages guinéens avec module budget et consommation	Direction Nationale de la Statistique	12	4,416
Kenya	1997	Welfare Monitoring Survey III	Central Bureau of Statistics	3	10,874
Malawi	1997	Integrated Household Survey 1997/98	National Statistical Office	12	10,698[b]
Mozambique	1996	Mozambique *inqerito nacional aos agregados familiareas sobre as condicoes de vida*	Instituto Nacional de Estatistica	15	8,273
Rwanda	2000	Enquête intégrale sur les conditions de vie des ménages au Rwanda	Direction de la Statistique du Ministère des Finances et de la Planification Economique	Urban areas: 15 Rural areas: 12	6,420
Senegal	2001	Enquête Sénégalaise aupres des ménages II	Direction de la Prévision et de la Statistique	4	6,052
Tanzania	2000	Tanzanian Household Budget Survey	National Bureau of Statistics of Tanzania	12	22,178
Uganda	1999	Uganda National Household Survey 1999/2000	Uganda Bureau of Statistics	12	10,696
Zambia	1996	Zambia Living Conditions Monitoring Survey—I (1996)	Central Statistical Office	3	11,763

[a]This survey was undertaken in two rounds of 2–3 months each, representing key seasons of the annual cycle.
[b]The number of households surveyed was 12,960, but 2,262 were dropped from the data set before its release (see Appendix B).

Data Collection

Table 3.1 gives some basic information on the surveys. Most were conducted in the late 1990s, with Guinea (1994) and Senegal (2001) being the only exceptions. For the majority, data collection was distributed evenly throughout a full year in order to capture seasonal variability. The Kenya, Senegal, and Zambia[13] surveys took place over 3 months only, however, and the Burundi survey over 6. Sample sizes range from 4,416 households for Guinea to 22,178 for Tanzania. Detailed information on the data collection is given for each country in Appendix B.

The surveys were conducted using two- (or three-) stage stratified sampling designs, thus ensuring full geographic coverage and representativeness at the national level.[14] Although there is great variation, the most common design was stratification into urban and rural areas within 5–10 major administrative regions, followed by random sampling of communities (the primary sampling units, or PSUs) within the strata, and then random sampling of households within

[13]The seasonality issue for these three countries is addressed in Chapter 4.

[14]The Senegal sample excludes some areas within two of the country's 10 regions, Ziguinchor and Tambacouna, because of insecurity or "lack of reliable information." The Uganda sample excludes 4 of the country's 45 districts, which were inaccessible at the time of the survey.

communities. When such complex sampling designs, rather than simple random sampling, are used, it is important to correct for the design so that any calculated statistics apply to the population group of interest (Deaton 1997). In this study, sampling weights provided with the surveys and variables delineating the strata and PSU for each household were used to correct for the sampling design in the calculation of all food security measures.[15]

Table 3.2 gives more details about the data collection for each country. It shows wide variation in the number of food items for which data were collected, the means of data collection (interview or diary), the sources of food acquisition for which data were collected, as well as the recall and reference periods for food data collection.

The number of food items ranges from a low of 33 (Burundi) to a high of 274 (Malawi). Despite the varying degree of specificity in the delineation of food items, they cover all of the food groups making up the human diet.[16] In most surveys the commonly consumed foods within a food group are listed individually followed by a residual category to capture all other foods in the group. For example, a questionnaire may list “mangoes,” “bananas,” and “oranges” individually, followed by the item “other fruits.”

Although data were collected on both food purchases and consumption of food from home production for all of the countries, in Burundi, Guinea, Kenya, and Rwanda, no data were collected on acquisition of food in kind. In Ghana and Uganda, households were asked to report on receipt of gifts of food. In Ethiopia, Malawi, Mozambique, Senegal, Tanzania, and Zambia, they were asked to report on foods received in kind from gifts as well as other sources. For example, the Ethiopia questionnaire includes categories for foods received from governmental organizations, nongovernmental organizations, other households, from abroad, collected, in return for employment, and so forth. Other surveys (for example, Zambia) simply ask for food “received” along with home-produced food.

The recall periods range from 1 day to 2 weeks. The only exception among the data sets considered here is Zambia, where it is 30 days for maize purchases and 2 weeks for all other acquisitions. A recall period of 1 day is assumed whenever the diary method is used. In some cases the recall period differs for urban and rural households (Guinea, Rwanda, Senegal) or for different sources of food acquisition (Malawi, Zambia). In some surveys, enumerators made multiple visits to households. For example, for the Guinea and Rwanda surveys, urban households were visited 10 times and asked to recall their food acquisition over the last 3 days. Rural households, whose monetary expenditures are less dependent on a monthly paycheck, were visited seven times with a 2-day recall period. The Ethiopia survey was undertaken in two rounds, with households visited eight times in each round and given a 3- to 4-day recall period.

The reference period of a survey is the time period over which food data collection takes place in total. In the cases where there was only one visit to each household, the

[15]Questions have been raised about bias in the estimation of the distribution of household energy availability across households when data are derived from a survey with a “complex” sampling design rather than using the equal-probably selection method (Arbia 2003; Naiken 2003; Srivastava, Rai, and Ramasubramanian 2003). However, as pointed out by David (2003) and confirmed by Deaton (Personal communication [e-mail], June 5, 2004), design-unbiased estimates are now standard outputs from modern survey data-processing software. For this analysis, all sample means and proportions were calculated using the “svy” commands in STATA Special Edition Version 8 (StataCorp 2003).

[16]The foods can be classified into the 12 groups used to construct the diet diversity measure (see Table 2.1). Note that there is one exception to the above statement among the data sets examined here: the food group “eggs” is not covered in the Burundi data set.

Table 3.2 Food data collection

Country	Number of food items[a]	Means of data collection	Food sources for which data collected	Number of visits	Recall period (days)	Reference period[b] (days)
Burundi	33	Interview	Purchases, home production	1	15	15
Ethiopia	213	Interview	Purchases, home production, in kind	8[c]	3–4	28
Ghana	109	Diary and interview	Purchases, home production, gifts	Literate: 6 Illiterate: 30	1	30
Guinea	112	Interview	Purchases, home production	Urban: 10 Rural: 7	Urban: 3 Rural: 2	Urban: 30 Rural: 14
Kenya	70	Interview	Purchases, home production	1	7	7
Malawi	274	Diary and interview	Purchases, home production, in kind	Purchases Literate: 1 Illiterate: 9 Other: 1	Purchases Literate: 1 Illiterate: 3 Other: 3	Purchases: 14–28 Other: 3
Mozambique	217	Interview	Purchases, home production, in kind	3	First Visit: 1 Others: 3	7
Rwanda	94	Interview	Purchases, home production	Urban: 10 Rural: 7	Urban: 3 Rural: 2	Urban: 30 Rural: 14
Senegal	258	Diary and interview	Purchases, home production, in kind	Purchases Literate: 1[d] Illiterate Urban: 10 Rural: 7 Other Urban: 10 Rural: 7	Purchases Literate: 1 Illiterate: 3 Other: 3	Urban: 30 Rural: 21
Tanzania	129	Diary and interview	Purchases, home production, in kind	Literate: 2–3 Illiterate: 30	1	30
Uganda	47	Interview	Purchases, home production, gifts	1	7	7
Zambia	40	Interview	Purchases, home production, in kind	1	Purchases Maize: 30 Rest: 14 Other: 14	Purchases Maize: 30 Rest: 14 Other: 14

[a]This is the number of food items used for the final analysis, not the original number listed in the questionnaire. In some cases fewer food items are used for the analysis because some had to be combined for conversion to metric quantities.
[b]A survey's reference period for food data collection is the total time period for which food acquisition is recorded. In the cases where there was only one visit to each household, the reference period equals the recall period. However, when there were several visits, the reference period generally equals the number of visits multiplied by the recall period. In the few cases where the diary method was used, the recall period is 1 day (households are to fill in the diary on a daily basis), and the reference period is the length of time the diary is maintained.
[c]This survey was undertaken in two rounds. The information here is for each individual round.
[d]The multiple visits made by the enumerator to households with a literate member were only for recording the diary entries over the last 3 days.

reference period equals the recall period (Burundi, Kenya, Uganda). However, when there were several visits, the reference period generally equals the number of visits multiplied by the recall period. In the cases where the diary method is used, the reference period is the length of time the diary is maintained. The most common reference periods for the surveys in this study are 1 week, 2 weeks, and 1 month. The only exception is Malawi, for which data on home-produced and in-kind food acquired were collected using a 3-day reference period.

Calculation of Metric Quantities of Food

As discussed in Chapter 2, the raw data entered from the survey questionnaires—whether expenditures or quantities—must be converted into metric quantities before the energy content of food acquired can be determined.[17] When households are asked to report expenditures on food acquired only (and not the quantity), expenditure must be divided by a metric price to derive metric quantities. When they report in terms of quantities in nonmetric or "local" units of measure, as is usually the case, these quantities must be multiplied by the corresponding metric weight of the food. Examples of local units of measure are heaps, baskets, bundles, calabashes, bowls, bottles, cans (which generally have nonstandard sizes), 20-liter tins, and 1-kilogram margarine tins (which have standard sizes). Another common unit of measure is "unity" (also referred to as "piece" or "single"), which is commonly used when reporting acquisition of fruits, vegetables, and eggs.

Table 3.3 details the types of food acquisition data collected in each survey. Often the approach differs for food purchases, on the one hand, and home-produced foods and foods received in kind, on the other. For purchased food, expenditure data are always collected directly from households or, as in the case of Kenya, can be calculated directly by multiplying a food's reported local quantity by its reported price. In many surveys quantity in local units is collected as well. For home-produced foods and foods received in kind, local quantity and unit of measure are always collected, sometimes complemented by expenditures or price.

To convert to metric quantities, three methods were used, with the choice of method depending on the type of data collected and the availability of complementary data from another source to convert to metric quantities.

Method A: Local Quantity × Metric Weight

This method was used where households were asked to report food quantities, and either the quantities were reported directly in metric units (in which case the metric weight is implicit) or they were reported in nonstandard units and complementary metric conversion factors were available. In the latter case, metric weights were obtained from one of three sources: (1) weighing of observable quantities at the household by the enumerators, (2) collected in local markets as part of a community price survey, or (3) available from preexisting data bases, such as the United States Department of Agriculture Nutrient Database for Standard Reference, Release 15 (USDA 2003) (for foods reported in unities) or other surveys. When foods were reported in volumetric measures (liters, milliliters), specific gravities from FSANZ (2004) were used to convert to metric weights.

Method B: Expenditure/(Metric Price)

This method was used to "recover" quantities acquired when households reported their

[17]Tables of the energy composition of foods give calorie conversion factors in units of kilocalories per 100 grams of food weight.

Table 3.3 Types of food data collected and methods of conversion to metric quantities

	Food purchases		Home-produced foods and foods received in kind	
Country	Type of data collected	Conversion method	Type of data collected	Conversion method
Burundi	Expenditure	B	Quantity, unit of measure	A
Ethiopia	Quantity, unit of measure, expenditure	A (98%) B (2%)	Quantity, unit of measure, expenditure	Same as purchases
Ghana	Expenditure	B C (73%)	Quantity, unit of measure, price	A (27%)
Guinea	Expenditure	B C (70%)	Quantity, unit of measure, price	A (30%)
Kenya	Quantity, unit of measure, price	A (58%) B (42%)	Quantity, unit of measure, price	Same as purchases
Malawi	Quantity, unit of measure, expenditure	B B (12%)	Quantity, unit of measure, estimated value	A (88%)
Mozambique	Quantity, unit of measure, expenditure	A (27%) B (73%)	Quantity, unit of measure, estimated value	Same as purchases
Rwanda	Expenditure	B C (53%)	Quantity, unit of measure, price	A (47%)
Senegal	Quantity, unit of measure, expenditure	A (73.8%) B (24.6%)	Quantity, unit of measure, expenditure	Same as purchases
Tanzania	Quantity, unit of measure, expenditure	A (99%) B (1%)	Quantity, unit of measure, expenditure	Same as purchases
Uganda	Quantity, unit of measure, expenditure	A (92%) C (8%)	Quantity, unit of measure, estimated value	Same as purchases
Zambia	Expenditure	B	Quantity, unit of measure, price	Same as purchases

Notes: Method A: Local quantity × metric conversion factor; Method B: Expenditure/metric price; Method C: Local quantity × (ratio of local to metric price). By “same as purchases” is meant that a distinction between purchases and other sources of acquisition was not made in choice of method for conversions to metric quantities. Thus, the percentage of observations for which each method was used applies to all observations together, regardless of the source.

food expenditures (but not quantities), and complementary metric prices were available. Sources of metric prices were (1) derived from household-reported metric prices or unit values (calculated as expenditure divided by metric quantity),[18] (2) collected in

[18]In any given survey, depending on the food, at least some households report directly in metric quantities. If expenditures are also available, a metric unit value could be derived as an estimated price. Household-level unit values used to estimate metric prices for other households were used only if at least five households reported a price for the food at a given geographic level. For instance, if a metric unit value was available for a food for at least five households in a community, then a community price was calculated and used for other households in the community if needed.

local markets as part of a community price survey, or (3) collected as part of a separate survey, the most common being a Consumer Price Index Survey carried out in all regions of a country.[19]

Method C: Local Quantity × Ratio of Local to Metric Price

This method was used when local quantities were available but complementary metric weights were not. The method can either be interpreted as estimation of a metric weight using relative prices as a proxy (approximating Method A) or as dividing estimated expenditures by a metric price (approximating Method B). For units of measure with standard sizes, price ratios were taken as the median over all households in the sample with a reported local unit price for a food. For units of measure with nonstandard sizes, price ratios were taken using the local unit price (or calculated unit value in the case of Uganda) reported at the household level.

Table 3.3 gives the conversion methods employed for each survey. Further details can be found in Appendix B. The most commonly employed methods are A and B. Method C is used only for 8 percent of observations in Uganda, roughly 70 percent of home-production or in-kind observations in Ghana and Guinea, and 53 percent of these observations in Rwanda.

The Energy Content of Foods and Energy Requirements

Once conversion to metric quantities has taken place, determination of the energy content of foods acquired for consumption in the home is straightforward. The sources of calorie conversion factors for each country are given in Appendix B. Where a country has its own food composition table, this is used as the primary source of calorie conversion factors. Where not, the table of a nearby country or the Africa food composition table (USDHEW/FAO 1968) was used. In some cases the American food composition table (USDA 2003) was used for foods known to vary little in calorie composition across countries. The actual energy value of a food acquired was computed as metric quantity multiplied by the food's calorie value, which was then multiplied by the food's edible portion. Edible portions are generally near 100 percent for grains (including flours derived from grains) and beverages but are lower for fruits, vegetables, roots and tubers, and animal products.

A meta-database containing the calorie values of all foods encountered in the surveys was constructed using available food composition tables from Sub-Saharan Africa as well as the American food composition table (USDA 2003). The values were compared across sources, and any suspect cases were dropped. Although the Africa food composition table was created in 1968, its calorie values are quite consistent with more recent tables and with the USDA tables, which were compiled using the most up-to-date laboratory techniques.

For foods consumed outside the home, only total expenditures are reported, which obviously hampers direct conversion to energy values. The only way to take this source of food acquisition into account is to apply the price per calorie of foods acquired for consumption inside the home to the expenditures on food consumed outside of the home. Although this method undoubtedly reduces the accuracy of estimates of house-

[19] In the context of the Data Food Networking (DAFNE) project, the Irish 1987 Household Budget Survey was used to show that for a subsample of foods for which metric quantities and expenditures were collected directly, the use of retail prices to convert expenditures to quantities resulted in a 10 percent or less margin of error (Friel et al. 2001).

Table 3.4 Recommended daily caloric intakes

Age group	Kilocalories per day		
Young children			
<1	820		
1–2	1,150		
2–3	1,350		
3–5	1,550		
Older children	Boys	Girls	
5–7	1,850	1,750	
7–10	2,100	1,800	
10–12	2,200	1,950	
12–14	2,400	2,100	
14–16	2,650	2,150	
16–18	2,850	2,150	
Men	Light activity	Moderate activity	Heavy activity
18–30	2,600	3,000	3,550
30–60	2,500	2,900	3,400
>60	2,100	2,450	2,850
Women	Light activity	Moderate activity	Heavy activity
18–30	2,000	2,100	2,350
30–60	2,050	2,150	2,400
>60	1,850	1,950	2,150

Source: FAO/WHO/UNU (1985), as published in Hoddinott (2001).

hold energy availability, it is the approach taken here by necessity.[20]

As discussed in Chapter 2, the energy requirements used are the average energy requirements of specific age–sex groups for basal metabolic function and light activity. These are given in Table 3.4, with the requirements for moderate and heavy activity also included for reference. A household's total energy requirement is calculated as the sum of the requirements of all household members. An additional 500 calories is added for each child less than 1 year old to account for the greater needs of breast-feeding mothers.[21]

Data Cleaning

As discussed in Chapter 2, food acquisition data collected in household expenditure surveys are subject to a host of errors, from reporting on the part of households to recording on the part of enumerators to entering on the part of data entry operators. The raw data were subjected to thorough cleaning so as to avoid any influence of major

[20]The cost of energy is surely higher away from home because of labor costs, profits, and the fact that higher-cost foods (for example, meat) are more likely to be eaten when away from home. If this difference alone is considered, the estimation method overestimates energy availability from food eaten away. However, the fact that the caloric value of the foods eaten away is also likely to be higher counteracts the price effect. Thus, the direction of bias from the method is indeterminant without further research.

[21]Unfortunately the extra energy needs of pregnancy cannot be taken into account because the pregnancy status of household members was not recorded.

errors on the estimates of food energy availability. Data cleaning took place in three stages.

First, for each food, weights of foods in local units of measure, reported prices, and derived unit values were cleaned manually by examination for outliers at both ends of the distribution, often separately for each major region of a country. Outlying prices and weights were set to missing and not used in further calculations. When outlying unit values were detected, both the expenditure and quantity used to calculate them were set to missing.[22]

In a second stage, the computed metric quantities of individual foods were cleaned. Any quantity per household adult equivalent[23] that was more than three standard deviations from the sample median value was replaced with an estimated value using ordinary least-squares (OLS) regression. This technique was also used to replace values set to missing in stage 1 of the data cleaning. The independent variables in the food-specific regression equations were number of household adult equivalents, variables representing the age–sex composition of the household, whether it is female headed, age of the household head, whether at least one adult member has a primary or secondary education, the number of assets owned by the household (calculated from survey-specific lists of assets), whether the household is located in an urban area, region of residence, and month of survey, where appropriate. Note that because this technique takes into account household-specific characteristics, it preserves variation in the data better than the more common method of replacement with means or medians of other households.

The third stage of data cleaning took place for household-level energy availability. A household's total calories per adult equivalent was replaced with an estimated value using OLS prediction regressions (with the same regressors as above) when (1) a metric quantity that was identified as an outlier or set to missing in the cleaning process could not be estimated[24] or (2) not enough information was available to estimate calories from food consumed outside of the home[25] or (3) a household had no reported food acquisition data.

Some households were dropped from the analysis altogether. This was the case if (1) more than 50 percent of the quantities of foods it reported were set to missing or identified as outliers, or (2) its calculated daily energy per adult equivalent was greater than 12,000 kilocalories. Note that no lower bound was used because it is possible, if unlikely, for a household to acquire no food at all over a survey's reference period.

Table 3.5 summarizes the number of dropped households and predicted observations for each country. The highest percentage of households dropped from the analysis was 2.5, for Kenya, where 275 of the 10,874 sampled households were dropped. The percentages of food acquisition observations with metric quantities estimated using prediction regressions are generally very low, with the country having the most being, again, Kenya at 6.5 percent. Although for the majority of countries the percentage

[22]The only exception is Senegal, for which quantities were deemed to be the source of the error rather than expenditures.

[23]See next section for the definition of an adult equivalent.

[24]In some cases, not enough nonmissing observations were available to allow running a regression.

[25]Households with more than 75 percent of total food expenditures on food acquired outside of the home were not considered eligible for the "price per calorie of food acquired for consumption in the home" method. These households' acquisition of in-home food was deemed to be too small, relatively speaking, to use for estimating acquisition of out-of-home food.

Table 3.5 Data cleaning: Dropped households and predicted values

Country	Number of households surveyed	Households dropped from analysis		Number of households retained for analysis	Food acquisition observations with predicted quantity (%)	Households with predicted energy availability (%)
		Number	Percentage			
Burundi	6,668	83	1.2	6,585	1.2	1.0
Ethiopia	17,332	26	0.2	17,306	2.4	0.12
Ghana	6,000	60	1.0	5,940	1.8	9.1
Guinea	4,416	44	1.0	4,372	2.0	0.8
Kenya	10,874	275	2.5	10,599	6.5	0.4
Malawi	10,698	176	1.6	10,522	1.8	15.3
Mozambique	8,273	125	1.5	8,148	3.7	0.9
Rwanda	6,420	55	0.9	6,365	3.8	0.5
Senegal	6,052	45	0.7	6,007	3.7	5.4
Tanzania	22,178	528	2.4	21,650	1.3	0.7
Uganda	10,696	106	1.0	10,590	4.2	5.8
Zambia	11,763	180	1.5	11,583	1.2	0.2

of observations with predicted energy availability is quite low, for Uganda and Ghana, it is near or greater than 10 percent.

Calculation of Household Size and Adult Equivalents

To calculate household energy availability, the total calories acquired by a household is divided by either the number of household members or the number of adult equivalents. When divided by adult equivalents, the fact that peoples' energy needs can vary substantially depending on their sex and age is taken into account.

A base estimate of the number of household members was first calculated using the definition of household membership followed in the household roster data collection specific to each survey. Following that, an attempt was made to determine the number of people who were actually present in the household at the time of the survey and thus potentially eating the food acquired. Some surveys directly included information on which members were present (Burundi and Senegal). Where this information was not available, but that on the duration of absence over the last year was, those members who were absent for more than 6 months were excluded from the household size calculation (Ghana, Guinea, Mozambique, Rwanda, and Uganda). Where no information was available, the base estimate of household size was employed. Note that in some of these cases the definition itself included a condition that members be present in the household over the last 6 months. An "adult equivalent" is defined using a man 30–60 years old as the reference category and comparative average energy requirements for medium activity (see Table 3.4) for the various other age and sex groups.

Household Calorie Availability: A Look at the Calculated Values

As noted in Chapter 2, the data collected in HESs represent household calorie *availability* rather than intakes. The household-level calculated values for these two variables will look very different from one another. Table 3.6 reports descriptive statistics for household daily calorie availability per capita. The means in the table differ from those reported in the next chapter because (1) they are not corrected for survey sampling designs, and (2) they represent household-level calorie availability per capita rather than calorie availability per capita per se. Figure 3.2 gives nonparametric

Table 3.6 Household daily calorie availability per capita: Descriptive statistics

Country	Number of observations	Mean	Standard deviation	Minimum	Maximum
Burundi	6,585	2,276	1,701	0	12,000
Ethiopia	17,306	1,684	682	137	6,292
Ghana	5,940	2,669	1,657	0	11,565
Guinea	4,372	2,713	1,590	6	11,533
Kenya	10,599	3,028	1,859	40	12,000
Malawi	10,522	1,878	1,518	0	11,265
Mozambique	8,148	2,436	1,779	0	11,563
Rwanda	6,365	2,013	1,322	1	11,871
Senegal	6,007	2,136	1,229	3	10,729
Tanzania	21,650	2,759	1,611	4	12,000
Uganda	10,590	2,910	1,488	38	11,755
Zambia	11,583	2,093	1,505	0	11,785

probability density functions of household calorie availability for each country.

It is important to note that the ranges of household calorie availability per capita are much wider than we would expect for household calorie intakes per capita. The widest range is 0 to 12,000 (for Burundi), and the narrowest is 137 to 6,292 (for Ethiopia). The minimums are obviously far below what is possible for human survival.

Figure 3.2 Nonparametric density functions of household food energy availability per capita estimated from household expenditure surveys

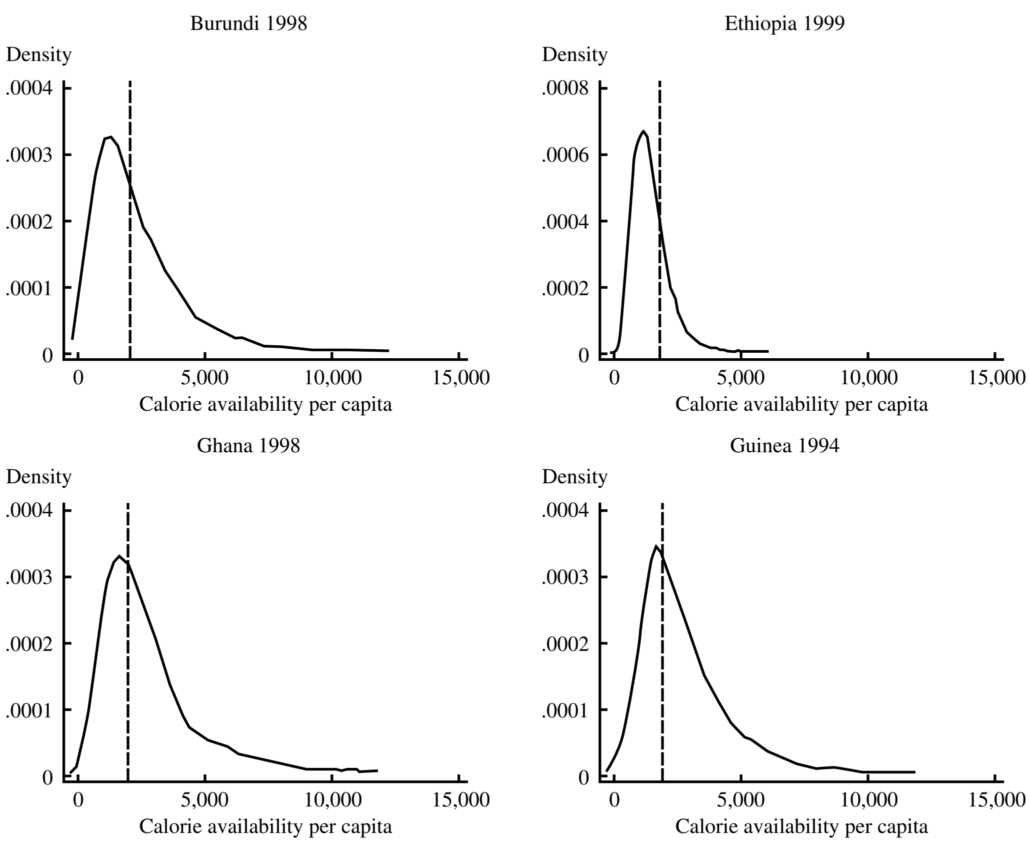
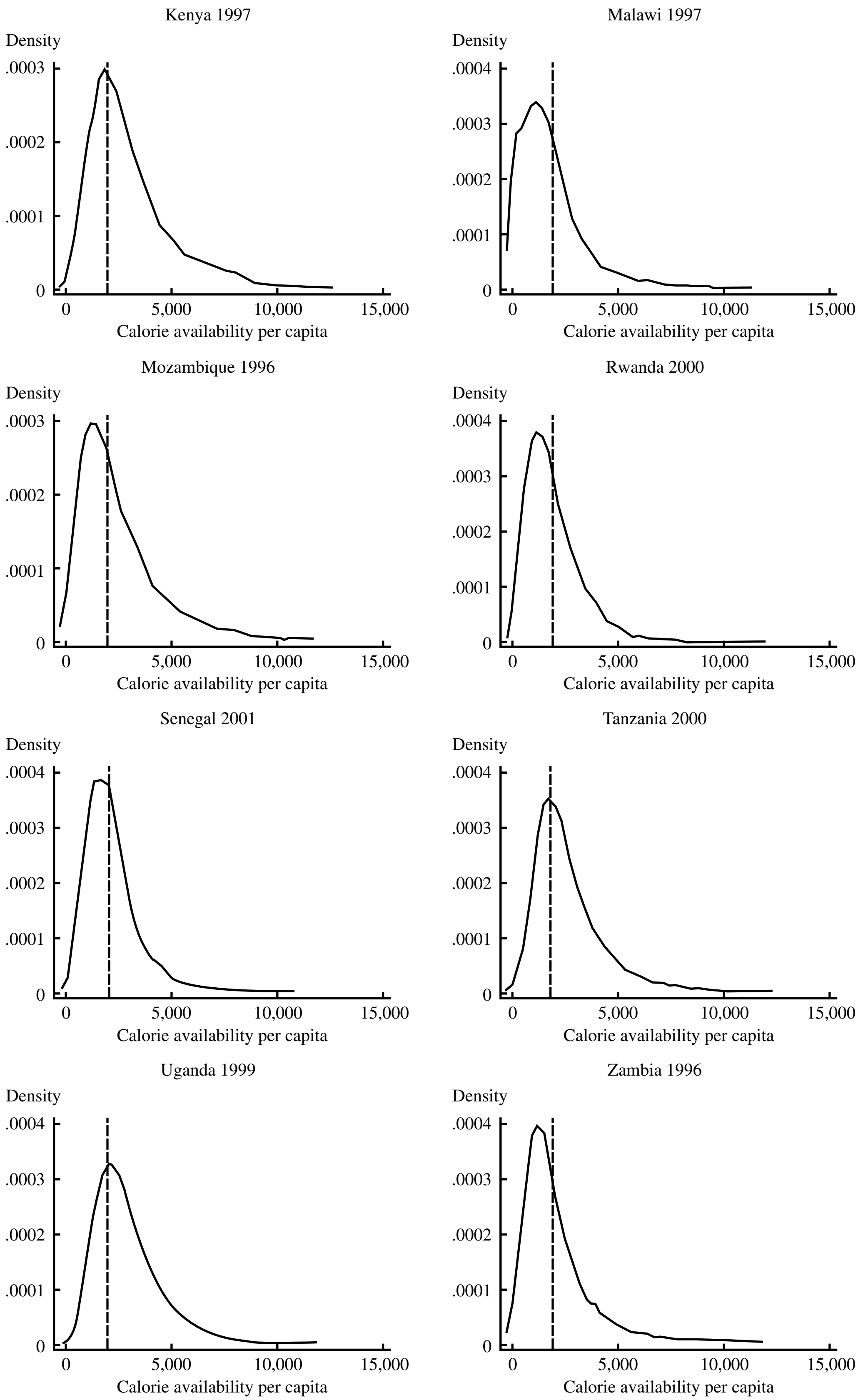


Figure 3.2—Continued



Note: Vertical lines are at the average per capita dietary energy requirement for each country when the average requirement for light activity is assumed.

The maximums are far above what a person could possibly eat in one day. The standard deviations should theoretically be much wider than for calorie intakes as well. Despite these differences, as discussed in Chapter 2, we can expect the mean to be the same regardless of which data source is used because the difference between availability and intakes is a result of deviations of household food acquisitions from consumption that are randomly distributed across households. Note that the probability distributions of household calorie availability are skewed to the right rather than taking on the bell-like shape of a normal distribution.

CHAPTER 4

Estimates of Food Insecurity

This chapter first presents national estimates of food insecurity and compares them across the 12 countries. It then moves on to look at food insecurity across regions within countries. Finally, it examines differences in the severity of food insecurity for people living in rural and urban areas, by income group, and for female- and male-headed households.

National Estimates: A Comparison across Countries

Table 4.1 reports on estimates of the diet quantity and quality measures of food security for the 12 countries. Starting with diet quantity, energy availability per capita ranges from 1,592 kilocalories per person in Burundi (1998) to 2,636 in Uganda (1999). It falls quite near or below the average energy requirement for light activity (roughly 2,050 kilocalories per person) for seven of the countries—Burundi, Ethiopia, Malawi, Mozambique, Rwanda, Senegal, and Zambia—signaling severe food insecurity problems. In these countries there is not enough food for all people to meet their requirements even if the food were to be distributed according to need.

The percentage of people who are food energy deficient ranges from 36.8 percent in Uganda to over 75 percent in Burundi and Ethiopia (see Fig. 4.1). The 95 percent confidence intervals for these estimates are reasonably narrow, with the widest being for Ghana (±3.8 percentage points from the estimate) (see Table C.2, Appendix C). The estimates are thus quite precisely measured. The Spearman correlation coefficient between energy availability per capita and the prevalence of food energy deficiency is –0.96 ($P = 0.000$), indicating a tight correspondence between national-level food availabilities and food energy deficiency in the region. The percentage of households that are food energy deficient is also given in Table 4.1 for reference.[26]

Clearly, food insecurity is a major problem in all 12 countries. At least one-third, and in most countries a much higher percentage, of the population is not consuming enough food to meet requirements for basal metabolic function and light activity.

Uganda, Kenya, Tanzania, Guinea, and Ghana form a cluster of countries with relatively low rates of food energy deficiency, in the 35–50 percent range. At the time of their surveys, these countries were in a situation of economic and political stability for the most part, with no recent adverse climatic shocks.[27] Nevertheless, they were experiencing ongoing problems

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[26]The percentage of households that are food energy deficient is lower than the percentage of people because households with low food energy availability tend to be larger.

[27]An exception is the northern region of Uganda, which was facing insecurity at the time of the survey.

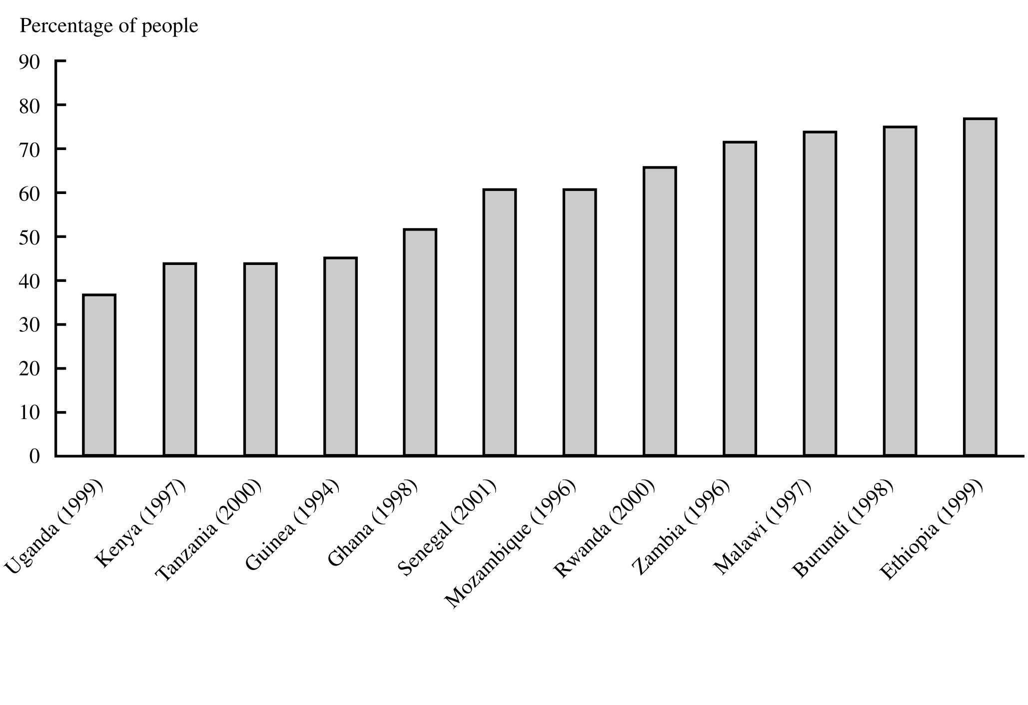
Table 4.1 Estimates of food security and insecurity, by country

		Food energy availability			Diet quality	
Country	Year	Energy availability per capita	Percentage of people food energy deficient	Percentage of households food energy deficient	Household diet diversity	Percentage of households with low diet diversity
Burundi	1998	1,592	74.8	68.2	4.5	44.0
Ethiopia	1999	1,648	76.4	72.0	4.8	36.4
Ghana	1998	2,328	51.4	43.6	5.8	8.0
Guinea	1994	2,510	45.1	37.3	6.0	7.7
Kenya	1997	2,579	43.9	35.1	5.4	25.0
Malawi	1997	1,614	73.3	66.9	4.4	49.8
Mozambique	1996	2,059	60.3	53.6	4.2	62.6
Rwanda	2000	1,860	65.3	60.6	4.5	49.2
Senegal	2001	1,967	60.2	52.8	5.9	8.1
Tanzania	2000	2,454	43.9	37.5	5.9	9.7
Uganda	1999	2,636	36.8	31.9	4.4	50.9
Zambia	1996	1,764	71.1	63.1	4.6	43.7

of chronic poverty endemic in most Sub-Saharan African countries because of, among other factors, poor agricultural productivity and infrastructure, poor health outcomes, including HIV/AIDS, gender inequality, low levels of education, national debt, poor governance, poor prices for primary products, and, in some areas, high population densities and growth.

Uganda, the country with the lowest food energy deficiency prevalence among the 12 (37 percent), has been referred to as one of Africa's six "bright stars" (Sachs 2004). In addition to having particularly fertile soils, and thus great agricultural potential, at the time of its survey it had a stable, democratically elected government and a relatively fast-growing economy as a result

Figure 4.1 Percentage of people food energy deficient, by country



of the economic reform efforts of the Museveni government (FEWS NET 1997; Resnick 2004). At the time of their surveys, Kenya, Tanzania, and Guinea had relatively strong economies after years of economic reforms. Kenya's survey, in 1997, followed a year of poor weather conditions in several districts and low prices of maize, its staple crop. Maize imports were able to make up for the deficit (UNDHA 1996). Note that the survey took place April through June of the year, during the countries' long rains. The harvesting of crops from the short rains takes place in February and March, which may have offset the dip in food availability typically found during the rainy seasons of countries with unimodal rainfall patterns. Analysis of the seasonal patterns of energy availability in neighboring Uganda, which lies at the same latitude, shows that this time of year conforms with annual averages.[28]

Tanzania also experienced poor weather conditions in the years leading up to its survey, including a drought in 1996/97 and El Nino flooding in 1997/98 (Wobst 2001). Guinea was experiencing the destabilizing effects of the influx of refugees fleeing from civil wars in Liberia and Sierra Leone (U.S. Department of State 2004). Despite 15 years of economic reform and democratization in Ghana, the collapse of cocoa prices in the 1960s and 1970s and the subsequent economic collapse in the early 1980s has left it with a weak economy and slow growth in its agricultural sector. Although falling real food prices over the 1980s and 1990s may have improved the food security situation (Nyanteng and Asuming-Brempong 2003), this study nonetheless finds over half of its population to be food energy deficient.

With the exception of Senegal, all of the countries with aggregate food deficits had experienced adverse climatic shocks or severe conflict-induced instability in the years leading up to their surveys, with long-term consequences for both food supplies and the ability of households to gain access to them.

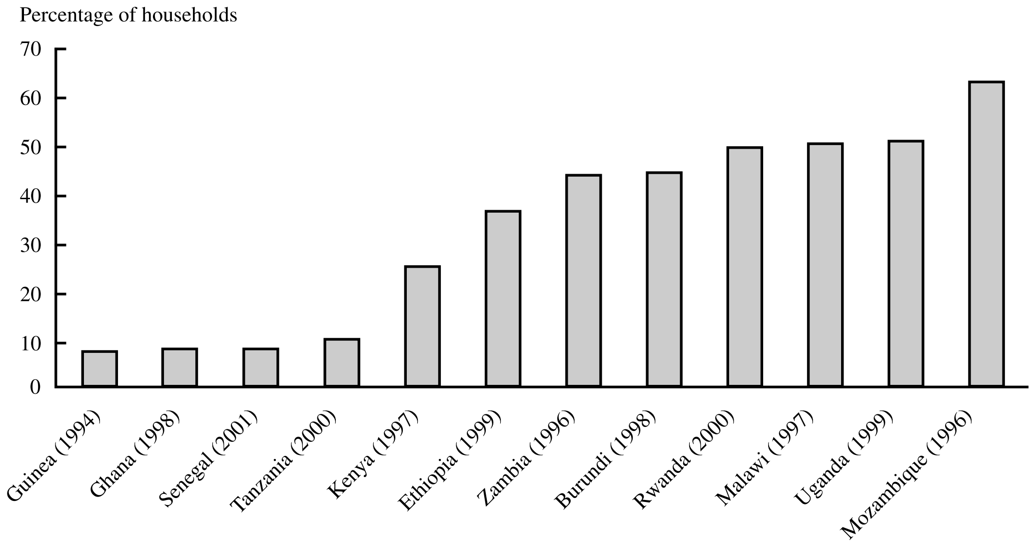
Ethiopia had been experiencing recurrent droughts for decades, including that of 1984, which was followed by a devastating famine in which over one million people perished. It had also been experiencing chronic political instability, including border wars, leading to internal and external refugee crises. The survey year itself was marked by the war with Eritrea, which exacerbated the country's weak economy. At the time of its survey, its poverty rate was among the highest in the world, at 82 percent (World Bank 2003).

At the time of their surveys, Rwanda and Burundi were recovering from ethnically motivated civil wars accompanied by violence and displacements that severely disrupted food production and completely devastated people's livelihoods (UNDHA 1996). Economic embargoes against Burundi by neighboring countries exacerbated the situation there (World Bank 2004).

Malawi, Zambia, and Mozambique were all recovering from the effects of severe droughts. The food security situation in these countries is also compounded by high prevalences of HIV/AIDS, estimated to be 15 percent in Malawi, 22 percent in Zambia, and 13 percent in Mozambique (Zhang et al. 2004). Malawi and Zambia, with food energy deficiency prevalences of 73 percent and 71 percent, respectively, share a similar story of endemic poverty exacerbated by economic crisis associated with agricultural liberalization in the 1980s that hurt small farmers and a major drought in 1992–93. The drought led to food shortages, credit defaulting, and a depletion of household assets that had the effect of deepening poverty even further (Frankenberger et al. 2003). Note that the Zambia survey took place only over 3 months during the countries' dry season, which is usually associated with higher-

[28]Mean monthly household food energy availability per capita for the 3 months is 2,901 kilocalories, which is quite close to the mean across all months of 2,877 kilocalories.

Figure 4.2 Prevalence of low diet diversity, by country



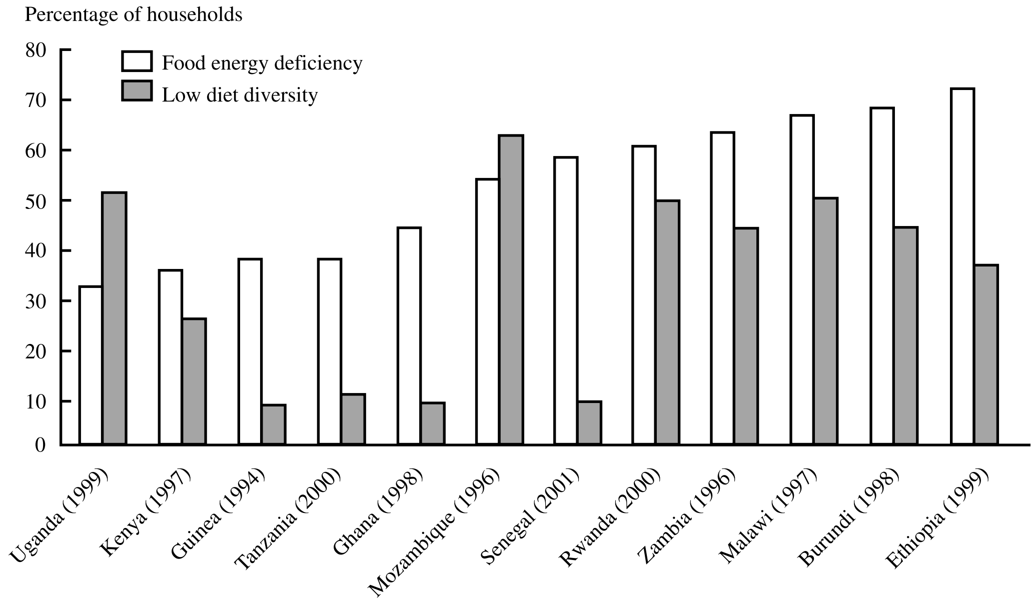
than-average food availability. The food energy deficiency rate may thus be understated, which is confirmed by analysis of the seasonal energy availability pattern in neighboring Malawi.[29] In addition to experiencing the effects of this same drought, at the time of its survey in 1996, Mozambique was recovering from the aftereffects of continuous civil war of 1979–92 that severely disrupted transport, communications, and markets and led to internal and external displacements (Arndt, Jensen, and Tarp 2000).

Senegal's ranking among countries such as Mozambique and Rwanda is unexpected. This is especially so given that its survey took place from February through May of the year, during the countries' dry season, when household food availability should be at its highest. However, although it experienced no major political or climatic shocks in the years leading up to its survey, its semiarid climate leaves it with endemic drought. Water is a basic constraint to agricultural production. Additionally, the 1990s witnessed a severe economic recession linked to long-term trends in population growth, land degradation, and declining prices of major exports. This was worsened by the 1994 CFA devaluation. The growth of its agricultural sector on which most people rely for their livelihoods was slow and variable throughout the 1990s (IFPRI 1998), and poverty increased over the decade (Ndiaye 2003).

The diet quality measures show a markedly different pattern across countries than the diet quantity measures (Table 4.1 and Fig. 4.2). The household diet diversity score is lowest for Mozambique, at 4.2 food groups out of 7.0, and highest for Guinea, at 6.0. Mozambique has the highest prevalence of households having low diet diversity: 63 percent. The West African countries have the lowest prevalences, with the average household's diet diversity score ranging from 5.8 to 6.0 out of the 7 food groups, indicating quite a varied diet. Less than 10 percent of the populations of these countries is classified as having low dietary diversity. With the exception of Tanzania, the East and southern African countries have much higher prevalences, ranging from 25 to 63 percent.

[29]From the Malawi (1996) survey, annual mean household energy availability is 1,840 kilocalories; that for the months of August–October is 1,910, 70 kilocalories higher.

Figure 4.3 Prevalences of food energy deficiency and low diet diversity, by country



Note: The food energy deficiency prevalences differ from those given in Figure 4.1 in that they represent the percentage of households that are food energy deficient rather than of people (see Table 4.1).

Figure 4.3 compares the prevalences of food energy deficiency and low diet diversity across the countries. The countries are ranked from lowest to highest energy deficiency prevalence. For comparability, these prevalences are for households rather than for individuals (see Table 4.1 for the difference). The correlation coefficient between the two measures is low, at 0.43, and not statistically significant ($P = 0.164$). Three of the countries with high prevalences of food energy deficiency—Mozambique, Rwanda, and Malawi—also have very high prevalences of low diet diversity, near or surpassing 50 percent. Three of the countries with relatively low prevalences of food energy deficiency also have very low prevalences of low diet diversity (Guinea, Tanzania, and Ghana), near or below 10 percent. However, no strong association between the two measures is apparent. A particularly large discrepancy in country rankings can be seen for Uganda, which ranks lowest for food energy deficiency but second-to-highest for low diet diversity. In this country there are likely substantial numbers of households that are not experiencing difficulties with access to sufficient food for meeting their energy requirements but that nevertheless have members who are not able to lead active, healthy lives because of diet quality problems. At the opposite extreme is Senegal, where a quite high and middling-ranked food energy deficiency rate is coupled with one of the bottommost rates of low diet diversity.

The absence of a strong association between the diet quantity and quality indicators suggests that these two aspects of food insecurity have quite different distributions across households as well as determinants. The differences may be associated with cultural traditions governing eating habits, climatic conditions governing food production variety, or availability of a variety of foods in local markets. They may also be associated with differences in socioeconomic determinants such as income and education.

Subnational Estimates: Looking within Countries

Appendix D contains food security profiles for the 12 countries that give the diet quantity and quality estimates for each country's main regions, by urban and rural residence, by total expenditure quintile, and by male- and female-headed household. In addition to the measures of focus in this study, two others are reported: (1) the percentage of energy from staples, a measure of diet quality, and (2) the percentage of expenditures on food, which is a measure of economic vulnerability to food insecurity.[30]

Regions within Countries

Ethiopia's high prevalence of food energy deficiency applies to all of its regions. The lowest prevalence is 66 percent in the Benishangul Gumuz region, and the highest is found in the Afar region, where 90 percent of all people are energy deficient. Similarly, Kenya's relatively low prevalence is fairly constant across its regions. The fertile central region has among the lowest rates of food energy deficiency, at roughly one-third of the population. Prevalences in the densely populated Western and arid Rift Valley provinces are slightly above 50 percent but still moderate, relatively speaking.

However, for many of the countries national food insecurity prevalences mask within-country variability that is important to take into account in food security policy decisionmaking. Despite Uganda's relatively low national rate of food energy deficiency (37 percent), nearly 60 percent of people in its northern region, which experienced conflict-induced instability and drought in the years preceding the survey, do not have access to sufficient food. Mozambique has particularly large extremes, with the Gaza region in the high-agricultural-productivity south having a food energy deficiency rate of 36 percent and Cabo Delgado in the low-productivity north (Garrett 1998) having a rate of near 75 percent. Guinea's "Guinee Forestiere" region stands out from its other regions as having a relatively low prevalence of food energy deficiency (27 percent).

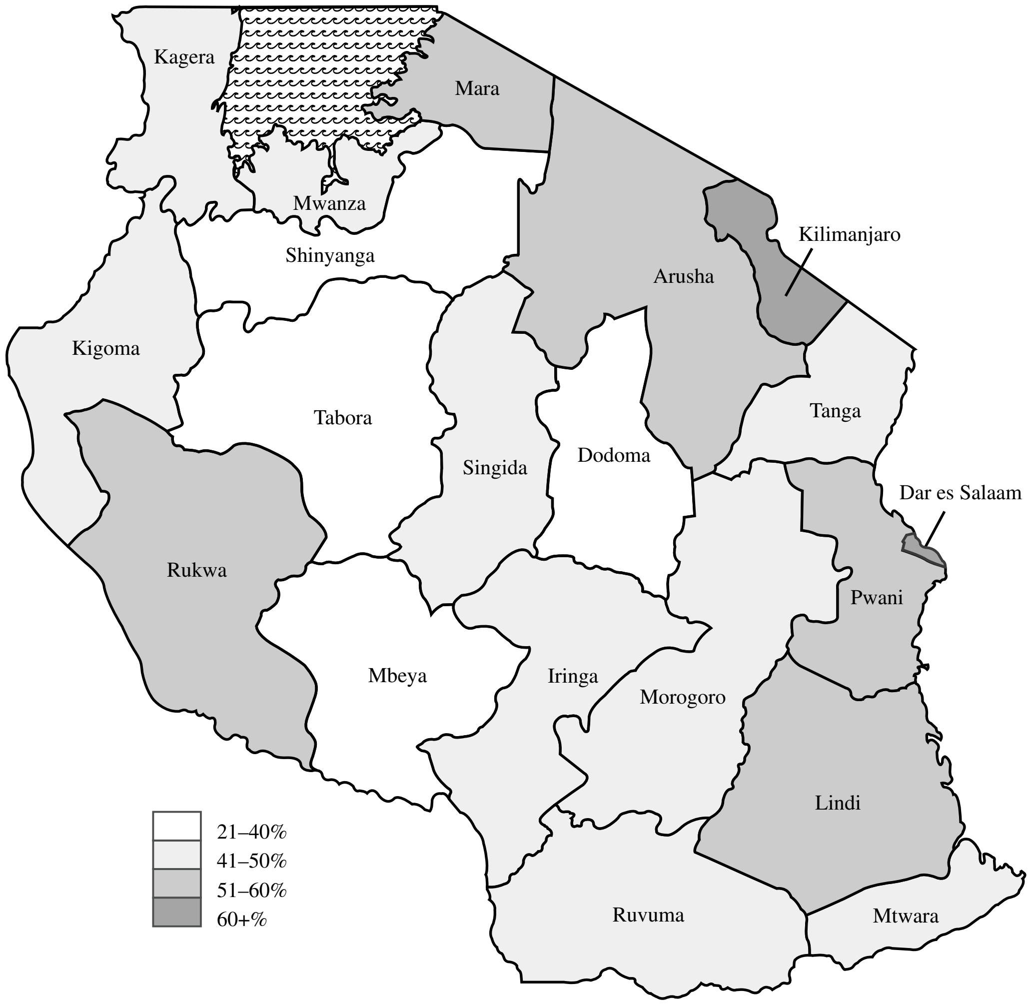
The diet quality measures show the same dual pattern, with some countries showing commonality across their regions and others great variability. The regions within Ghana and Guinea in West Africa show fairly common small prevalences of low diet diversity. Among the countries with very high prevalences nationally, variations among regions is quite high. Rwanda has one region (outside of the capital) that is doing far better than the others, Cyangugu, which has a low diet diversity rate of 21 percent compared with the national average of 50 percent.

In the example of Tanzania, Figures 4.4 and 4.5 present food insecurity maps to illustrate the wide variability that can be found within countries as well as the differing distributions of food energy deficiency and low diet diversity within them. The extremes of food energy deficiency prevalences run from as low as 22 percent in Tabora, the region with the lowest incidence of poverty (NBST 2002) to as high as 61 percent in the region of Kilimanjaro. The latter region is among several cereal-dependent north-central regions for which there was a decline in cereal production in the season immediately before the survey because of delayed rains (FAO 1999; Tanzania 2000).

With respect to diet quality, Tabora is again identified as a region with one of the lowest incidences of food insecurity. The highest rates of low diet diversity are found in the three most southern regions of the country (Lindi, Ruvuma, and Mtwara), in the lake region of Mara, and in Singida. Lindi has the highest rate, at 20.5 percent, associated with one of the highest rates of poverty, and the three southern regions are

[30]Households that spend high proportions of their incomes on food (say 70 percent or more) are vulnerable because if food prices are increased or their income is reduced, for example, through a job loss, natural disaster, or disease onset (for example, HIV/AIDS), they will have limited reserve for meeting their food needs (Maxwell et al. 1999).

Figure 4.4 Tanzania: Percentage of households food energy deficient, by region



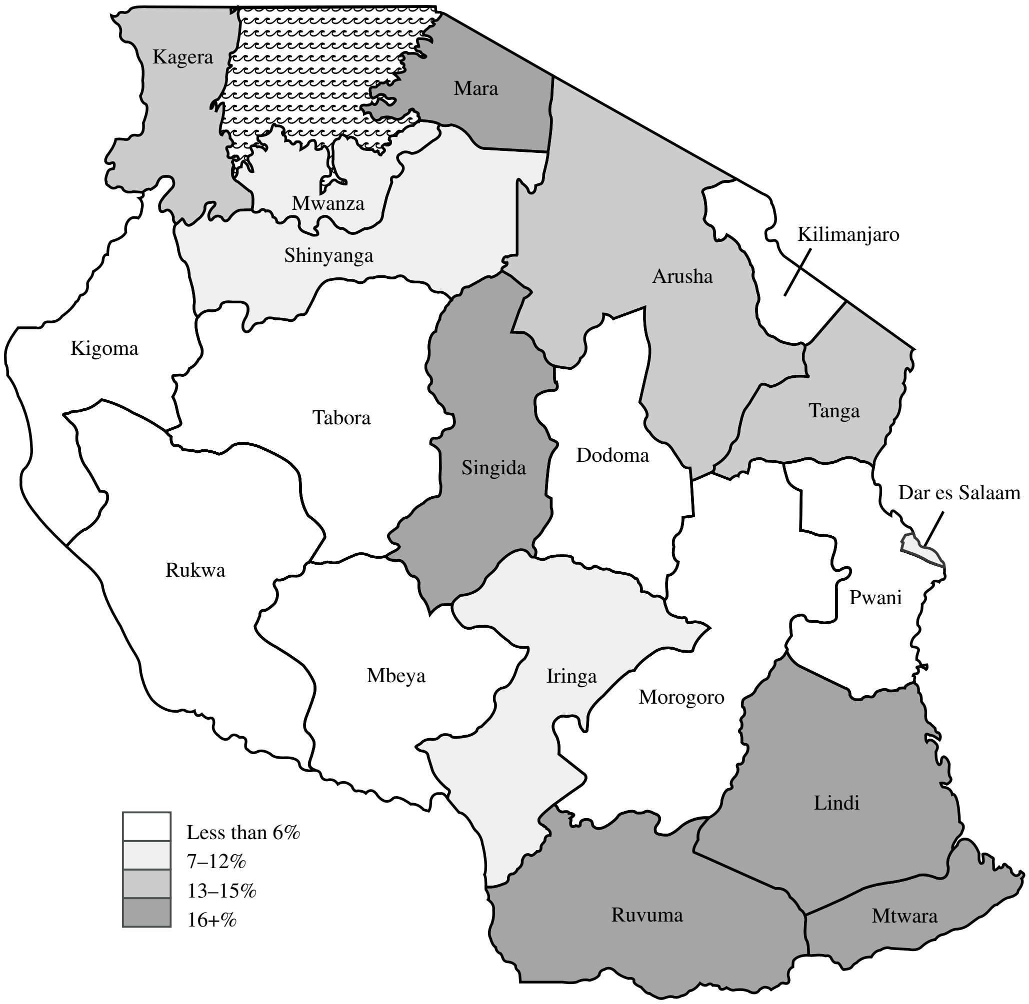
dependent on roots and tubers as their main staple (FAO 1999; Government of Tanzania 2000). It is noteworthy that the region with the highest prevalence of food energy deficiency, Kilimanjaro, also has one of the lowest prevalences of low diet diversity, at 3.4 percent. This may be related to the relatively high consumption of dairy products in the region (approximately 86 percent of households). As found for the cross-country results, there is little consistency between the relative severities of food insecurity across the regions as measured using the diet quantity and quality indicators.

The food insecurity maps for Tanzania used here illustrate one of the main advantages of using household-level data from HESs for measuring food insecurity compared to techniques that generate national-level estimates only. By combining household survey data with census data, it is possible to generate such maps at more finely disaggregated levels, making them more useful for policymakers and researchers (for example, Alderman et al. 2002).

Urban and Rural Areas

Table 4.2 reports the food security measures for urban and rural areas within countries. For seven of the countries, energy availability per capita is higher in rural areas than

Figure 4.5 Tanzania: Percentage of households with low diversity, by region



urban despite the fact that urban areas are known to have lower poverty rates. In fact, urban dwellers may have lower energy consumption than rural dwellers because they are more dependent on purchased foods that often have higher prices than in rural areas. Further, rural dwellers are more physically active and thus consume more energy and more energy-dense foods (starchy staples) in order to meet their higher actual (rather than normative) energy requirement (Higgins and Alderman 1997). When it comes to urban–rural differences in the prevalence of food energy deficiency, it must be kept in mind that this study uses an energy requirement for basal metabolic function and light activity, a minimum normative requirement below which a person is defined to be food energy deficient regardless of his or her actual activity level. Thus, urban–rural differences in the prevalence of food energy deficiency could go either way, as is found here. For four of the eight countries with substantial urban–rural differences in food energy deficiency—Burundi, Kenya, Mozambique, and Rwanda—prevalences are higher in rural areas. The difference is particularly high for Burundi, in which the percentage of rural dwellers who are deficient is 76 percent, while the percent of urbanites who are defi-

Table 4.2 Urban–rural differences in estimates of food security and insecurity

		Food energy availability				Diet quality			
		Energy availability per capita		Percentage of people food energy deficient		Household diet diversity		Percentage of households with low diet diversity	
Country	Year	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Burundi	1998	1,539	2,674	76.2	41.3	4.4	5.9	46.0	6.5
Ethiopia	1999	1,680	1,444	74.4	89.2	4.7	5.5	40.0	15.2
Ghana	1998	2,358	2,269	50.5	53.1	5.7	6.0	7.6	8.6
Guinea	1994	2,645	2,234	40.6	54.3	5.8	6.6	9.7	3.5
Kenya	1997	2,473	3,168	46.3	30.2	5.2	5.9	28.2	12.0
Malawi	1997	1,621	1,533	73.0	76.3	4.2	5.7	53.6	16.8
Mozambique	1996	1,935	2,524	62.9	50.7	4.0	5.1	70.1	29.3
Rwanda	2000	1,824	2,159	66.5	55.4	4.3	6.3	54.1	4.9
Senegal	2001	2,065	1,827	54.3	68.5	5.6	6.3	11.0	4.3
Tanzania	2000	2,487	2,314	41.8	52.7	5.8	6.2	11.0	5.1
Uganda	1999	2,658	2,493	36.3	40.7	4.2	5.3	56.5	21.1
Zambia	1996	1,750	1,788	71.2	70.9	4.1	5.6	60.9	11.8
Mean		2,091	2,203	58.1	57.1	4.8	5.9	37.4	11.6

Note: All values are corrected for survey sampling designs.

cient is 41 percent. For the other four countries (Ethiopia, Guinea, Senegal, and Tanzania), the opposite is true.

Note that because urban–rural differences in actual energy requirements associated with energy expenditures cannot be taken into account, we cannot infer from the above results that urbanites are more food insecure than rural dwellers, only that there are more urban households for which the light activity requirement is not met. It should also be noted that because of the relatively low level of urbanization in Sub-Saharan Africa, the absolute numbers of energy-deficient people in rural areas is still higher than those in urban areas (Ruel and Garrett 2004). Urban households have a clear advantage when it comes to diet quality. Their mean diet diversity score is 5.9, whereas that for rural households is 4.8, and in all countries it is higher in urban areas. Similarly, in all countries except Ghana, where the urban rate is just slightly higher than the rural rate, the percentage of households with low diet diversity is higher in rural areas. In addition to higher urban incomes, this can be explained by the better access to a wider variety of foods in close proximity in urban areas. Rural households are more likely to rely on their own production or to live farther away from markets where a variety of foods can be purchased.

Income Groups

We turn next to look at how the food security indicators differ across income groups, as defined by total expenditure quintiles.[31] In constructing the quintiles we use predicted

[31]Households' total and food expenditures were provided by the various government statistical agencies. Subsequently, total expenditures were recalculated after the original food expenditures had been replaced with that calculated as part of this study.

total expenditures per capita[32] rather than actual expenditures, applying the standard instrumental variables regression procedure used in the presence of measurement error (Green 1997). This approach is followed to overcome two measurement problems discussed in Chapter 2. The first is random measurement error associated with transitory expenditure fluctuations such that current expenditures can deviate greatly from long-run expenditures (Behrman and Knowles 1997; Filmer and Pritchett 1998). The fluctuations are most apparent in food expenditures, which make up a large percentage of households' total expenditures, manifesting itself in the availability–consumption gap associated with the drawing-down and accumulation of stocks. Unless these are corrected for, relatively rich households that happen to acquire very little food and other goods over the reference period of the survey could erroneously be classified as falling into the bottom quintiles and vice versa. The second problem is that of systematic measurement error caused by the fact that data are not collected on food given to pets and guests or wasted, which is greater for richer households (Bouis and Haddad 1992). In either case, estimates of food security indicators across the quintiles can be highly biased, causing the differences among the quintiles to be exaggerated. Note that in regard to calorie availability per capita, the correction made here is similar to that used to eliminate upward bias in calorie-income elasticities.

For the interested reader the estimates of the food security indicators across the quintiles when actual rather than predicted total expenditures are used to classify households into quintiles can be found in Appendix F, Table F.1. As can be seen there, for many countries estimates of daily energy consumption per capita are unreasonably low in the bottom quintile and/or unreasonably high in the top quintile. In the example of Burundi, the estimate for the bottom quintile is 688 kilocalories, far below the amount any human being could survive on. This quintile undoubtedly contains the survey households that were acquiring very little food over the survey reference period but nevertheless were drawing down on previously acquired food stocks to meet current consumption needs. The estimate for the top quintile is 4,055 kilocalories, above the amount that most human beings could comfortably eat in 1 day on a regular basis. This quintile contains households that were building up their food stocks during the survey reference period. Table 4.3 shows the results when predicted total expenditures are used to classify households into quintiles. The new bottom and top quintile estimates of calorie consumption for Burundi are more reasonable, at 1,193 and 3,683 kilocalories, respectively.

In regard to the analysis at hand, the percentage of people food energy deficient generally falls dramatically across households from the bottom 20 percent of the income distribution to the top 20 percent (Table 4.3, column 2). The average food energy deficiency prevalence of the bottom quintile is 67 percent; that of the top is 40 percent. Burundi displays a particularly large degree of inequality across the quintiles, with 86 percent of people in the bottom quintile food energy deficient and only 14 percent in the top quintile. For some countries,

[32] They are predicted using as instruments asset ownership as well as other longer-run characteristics of households such as education, household demographics, and region of residence. The number of assets for which data were collected varies from 9 (Uganda) to 27 (Tanzania). For the asset ownership measure a simple additive, per capita index is created, where ownership dummy variables taking values of 0 or 1 are summed and divided by the number of household members. Note that only "consumption" assets (such as radios, bicycles, and household appliances) are used rather than "productive" assets (e.g., hoes) because including the latter would make rural households that rely on agricultural production as their main source of income appear to be relatively better off than urban households.

Table 4.3 Differences in estimates of food security and insecurity across total expenditure quintiles

	Food energy availability		Diet quality	
Expenditure quintile	Energy availability per capita (1)	Percentage of people food energy deficient (2)	Household diet diversity (3)	Percentage of households with low diet diversity (4)
Burundi (1998)				
Quintile 1	1,193	85.9	3.9	60.4
2	1,508	77.6	4.6	42.5
3	1,810	68.6	4.7	37.1
4	2,330	54.3	5.0	25.6
5	3,683	13.9	5.7	15.7
Ethiopia (1999)				
Quintile 1	1,558	79.9	4.9	34.8
2	1,695	72.3	4.7	43.1
3	1,769	72.1	4.7	39.4
4	1,757	76.1	5.0	32.8
5	1,827	73.3	5.6	12.3
Ghana (1998)				
Quintile 1	1,973	62.6	5.6	7.0
2	2,177	55.5	5.8	5.2
3	2,405	47.5	5.9	5.6
4	2,588	42.9	6.0	8.1
5	3,189	29.2	5.9	13.7
Guinea (1994)				
Quintile 1	2,296	50.3	5.6	12.2
2	2,794	34.9	6.0	5.8
3	2,563	45.7	6.4	1.5
4	2,371	53.2	6.5	4.6
5	2,984	32.8	6.4	9.0
Kenya (1997)				
Quintile 1	2,095	57.3	5.1	30.8
2	2,303	49.5	5.1	31.7
3	2,522	45.1	5.3	26.3
4	2,935	31.2	5.6	20.6
5	3,659	21.4	5.8	16.8
Malawi (1997)				
Quintile 1	1,289	82.0	4.0	63.1
2	1,475	77.5	4.0	61.9
3	1,721	71.0	4.2	53.3
4	1,890	64.9	4.5	44.0
5	1,852	66.3	5.3	25.7
Mozambique (1996)				
Quintile 1	1,603	72.4	3.9	74.7
2	1,845	65.5	4.0	72.1
3	1,969	62.2	4.1	65.4
4	2,301	51.5	4.4	52.4
5	3,371	31.9	4.9	36.3
Rwanda (2000)				
Quintile 1	1,378	80.8	4.0	65.3
2	1,612	73.4	4.2	59.4
3	1,944	61.9	4.5	48.2
4	2,161	55.9	4.7	43.8
5	2,634	41.1	5.7	18.6

(continued)

Table 4.3—Continued

Expenditure quintile	Food energy availability: Energy availability per capita (1)	Food energy availability: Percentage of people food energy deficient (2)	Diet quality: Household diet diversity (3)	Diet quality: Percentage of households with low diet diversity (4)
Senegal (2001)				
Quintile 1	1,885	59.0	5.6	11.4
2	1,985	56.2	5.8	6.8
3	2,102	58.7	6.0	5.7
4	1,898	64.2	6.3	4.9
5	2,172	53.2	5.9	11.8
Tanzania (2000)				
Quintile 1	2,246	49.3	5.7	13.1
2	2,562	39.5	5.9	10.1
3	2,613	39.4	6.1	5.5
4	2,543	43.2	6.1	5.5
5	3,015	35.9	6.0	9.5
Uganda (1999)				
Quintile 1	2,187	49.8	4.1	61.9
2	2,681	31.8	4.1	58.7
3	2,771	32.1	4.3	53.9
4	3,012	29.9	4.6	44.2
5	2,941	31.6	5.0	30.2
Zambia (1996)				
Quintile 1	1,475	79.9	4.0	64.0
2	1,722	71.6	4.2	54.7
3	1,847	67.9	4.7	40.5
4	1,958	66.8	5.2	24.1
5	2,445	50.7	5.7	14.4

Note: All values are corrected for survey sampling designs.

even the top quintile has a high prevalence, for example, Ethiopia (73 percent) and Malawi (66 percent), an indication of how poor these countries' populations are.

Looking at diet quality, we again find a substantial advantage as income increases. The average household diet diversity score of the bottom quintile is 4.7, whereas that of the top is 5.7. Interestingly, for Ghana, Guinea, and Senegal, the West African countries for which diet quality is not a major problem, the percentage of households with a low diet diversity declines across the lower quintiles but then rises again. Clearly income is a key determinant of food security, having a large influence over both diet quantity and diet quality.

Gender of Household Head

Table 4.4 reports differences in the food security measures between male- and female-headed households. Female-headed households are often considered to be more vulnerable to food insecurity because of their tighter time and income constraints than male-headed households (Caldwell et al. 2003; FAO 2004b; Gladwin and Thomson 2004).[33] On the other hand, many studies

[33]With respect to income, in a study using data from 10 developing countries, Quisumbing, Haddad, and Peña (2001) find that although female-headed households are worse off than male-headed households in terms of a number of measures of poverty, they are not consistently so.

Table 4.4 Differences in estimates of food security and insecurity for female- and male-headed households

		Food energy availability				Diet quality			
		Energy availability per capita		Percentage of people food energy deficient		Household diet diversity		Percentage of households with low diet diversity	
Country	Year	Male	Female	Male	Female	Male	Female	Male	Female
Burundi	1998	1,654	1,395	73.4	78.3	4.7	4.0	39.2	57.6
Ethiopia	1999	1,653	1,628	76.4	76.2	4.9	4.7	34.6	41.5
Ghana	1998	2,327	2,333	52.4	48.7	5.8	5.9	8.5	6.9
Guinea	1994	2,496	2,625	45.6	40.7	6.0	5.9	6.9	12.0
Kenya	1997	2,581	2,572	45.2	39.7	5.4	5.2	23.4	29.0
Malawi	1997	1,631	1,546	73.1	74.2	4.5	4.2	47.3	57.6
Mozambique	1996	2,045	2,124	60.8	58.2	4.2	4.2	62.6	62.4
Rwanda	2000	1,903	1,746	64.1	68.6	4.7	4.3	45.2	57.9
Senegal	2001	1,986	1,868	59.5	63.7	5.9	6.1	8.2	7.4
Tanzania	2000	2,460	2,427	44.2	42.8	5.9	5.9	9.6	10.1
Uganda	1999	2,687	2,460	34.7	44.4	4.5	4.2	48.6	57.2
Zambia	1996	1,762	1,774	71.5	69.2	4.7	4.3	40.8	53.1
Mean		2,103	2,045	58.7	59.0	5.1	4.9	31.2	37.7

Note: All values are corrected for survey sampling designs.

find that when women have the power to make decisions over the allocation of resources, which they do more in female-headed households, they tend to allocate their scarce resources toward goods that benefit the entire household, such as food, rather than only themselves (Haddad, Hoddinott, and Alderman 1997).

Table 4.4 shows that, on average, female-headed households have about the same rates of food energy deficiency as male-headed households. For three of the countries where there is a substantial difference (Ghana, Guinea, and Kenya), the rate is substantially higher for male-headed households. In Burundi, Rwanda, Senegal, and Uganda, the opposite is true. In terms of diet quality, outside of West Africa, where prevalences of low diet diversity are very low, female-headed households are doing worse than male-headed households in all but one country, Mozambique. These findings indicate that in East and southern Africa female-headed households are likely to be a vulnerable group when it comes to diet quality.

CHAPTER 5

Comparison with FAO Estimates and Related Measures

The first section of this chapter starts out by comparing household expenditure survey (HES) and Food and Agricultural Organization of the United Nations (FAO) estimates of national prevalences of food energy deficiency. The latter is being used to monitor progress on Millennium Development Goal (MDG) number one, to eradicate extreme poverty and hunger. The HES and FAO methods are used to estimate the same measure. We would thus expect them to have a strong positive association with one another. This is not the case, however, and the aim of the second section is to give some insights into why. The chapter next compares HES and FAO estimates for the study countries to two other indicators being used to monitor MDG goal number 1, poverty and child malnutrition prevalences, and to country rankings based on an expert opinion survey.

Comparison of HES and FAO Estimates of Food Energy Deficiency

Table 5.1 compares HES and FAO estimates of food energy deficiency. Figure 5.1 shows them graphically, with countries ranked from lowest to highest by the HES estimate. For some of the countries, they are quite close; for example, Kenya, Tanzania, and Mozambique. For others, however, they are far apart, with the greatest difference being for Malawi, where the FAO estimate is 41 percentage points below the HES estimate. Other countries with particularly large differences are Ghana, Senegal, and Ethiopia. In all cases where there are substantial differences between the estimates, FAO estimates of food energy deficiency are lower. The mean HES–FAO estimate difference is quite substantial, at 20 percentage points.

Overall, there appears to be a weak correspondence between the HES and FAO estimates. Their Pearson correlation coefficient is 0.46 and is not statistically significant ($P = 0.136$). Clearly, the two methods of measuring this aspect of food insecurity yield quite different pictures of its magnitude for the study countries. Further, the country rankings implied by the two sets of estimates give conflicting information about relative severities and thus appropriate targeting strategies for international agencies and initiatives with the objective of reducing food insecurity in Sub-Saharan Africa.

Why Do the HES and FAO Estimates Differ? Some First Insights

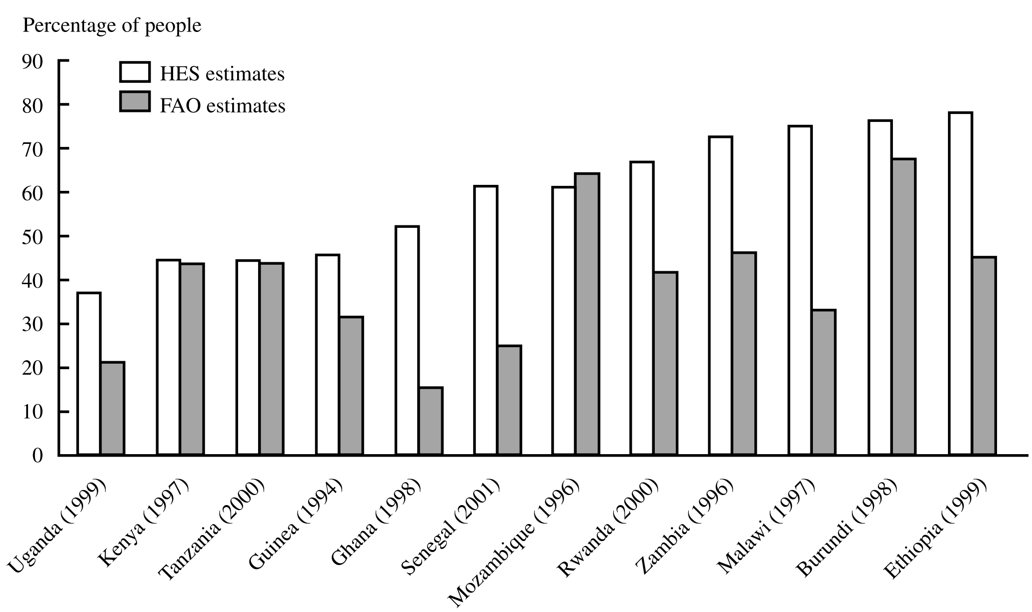
An in-depth investigation of this question is beyond the scope of this report. However, we can gain some initial insights by looking more closely at the method used to generate the FAO

Table 5.1 Comparison of HES and FAO estimates of national prevalences of food energy deficiency

Country	Year	HES estimate (%)	FAO estimate (%)	Difference (percentage points)
Ethiopia	1999	76.4	44	32.4
Burundi	1998	74.8	66	8.8
Malawi	1997	73.3	32	41.3
Zambia	1996	71.1	45	26.1
Rwanda	2000	65.3	41	24.3
Mozambique	1996	60.3	63	2.7
Senegal	2001	60.2	24	36.2
Ghana	1998	51.4	15	36.4
Guinea[a]	1994	45.1	31	14.1
Kenya	1997	43.9	43	0.9
Tanzania	2000	43.9	43	0.9
Uganda	1999	36.8	21	15.8
Mean		58.5	39	19.5

Note: Household expenditure survey (HES) estimates are from the AFINS project food security database. Food and Agriculture Organization of the United Nations (FAO) estimates are from FAO (1999–2002).
[a]The FAO estimate is for 1995–97, before country-level estimates began to be reported. There were no major changes in the country's per capita dietary energy supply—on which the FAO measure is based—over 1994–97.

Figure 5.1 Comparison of HES and FAO estimates of national prevalences of food energy deficiency



Source: See notes to Table 5.1.

estimates. This method is a "parametric" method, meaning that it relies on the use of parameters describing a distribution of a variable of interest in a population. The distribution is assumed to follow a particular shape. The method used in this report, by contrast, is referred to as "nonparametric," relying directly on the data for estimation of statistics describing a variable (Statsoft 2005). In this section, after describing the FAO method, we investigate why estimates of food energy deficiency based on the two methods differ by comparing the parameters employed in the FAO method with those derived from the HES data or assumed for the HES method. We then recalculate the FAO estimates using the HES parameters to get a sense of the influence of the parameter differences on the divergences in food energy deficiency estimates.

FAO Method: The Log-Normal Probability Distribution Framework

The method relies on the following key assumptions (Naiken 2003):

- Dietary energy consumption is distributed across each country's population according to a two-parameter log-normal probability distribution, where the key parameters are the mean and the coefficient of variation (CV) (standard deviation divided by the mean).
- The mean of the distribution is the daily dietary energy available per person in the country, referred to as the "dietary energy supply" (DES).
- The CV of the distribution can be represented by the variation across the population in food consumption attributable to two sources: household incomes and household energy requirements.
- The dietary energy requirement of the population corresponds to the age–sex group weighted average of the *minimum* energy requirement for light activity (corresponding to the lower limit of the range of acceptable body weight for a given height).[34]
- The area under the log-normal distribution to the left of the energy requirement gives the proportion of the population that is food energy deficient.

The method is illustrated in Figure 5.2. Mathematically, the proportion of people food energy deficient is calculated as follows. Let μ_i^* be country i's DES and CV_i^* be the country's coefficient of variation of dietary energy consumption. Then the standard deviation (σ_i) and mean (μ_i) of country i's log-normal distributions are calculated as:

$$\sigma_i = \sqrt{\ln(CV_i^{*2} + 1)}$$

$$\mu_i = \ln(\mu_i^*) - \frac{\sigma_i^2}{2}$$

These values are used to compute a z-score:

$$z - \text{score}_i = \frac{\ln(z_i) - \mu_i}{\sigma_i} \quad i = 1, \ldots, N,$$

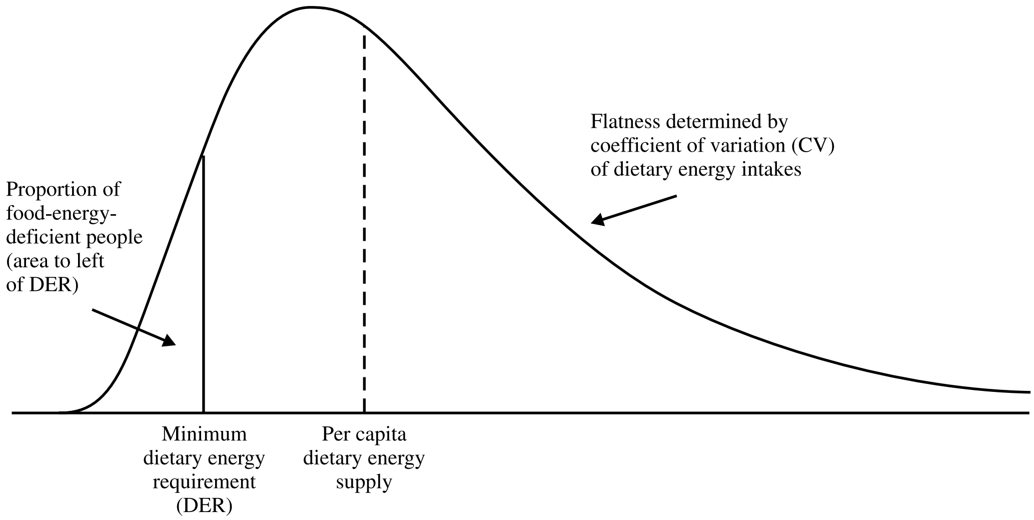
which can be looked up in a table of standard normal probabilities to find the estimated proportion of energy-deficient people.

Comparison of Dietary Energy Requirements Employed

The dietary energy requirement used for the FAO method is lower than that used in this report even though the same "light" activity level is assumed. Recall that the FAO/WHO/UNU (1985) requirements are based on a normatively specified body weight consistent with good health for each activity level. However, for a given height, there is a range of body weights that are consistent with good health. Therefore, there is a range of requirements for adults and adolescents

[34]For under-10-year-olds, the median, rather than minimum, of the range is employed. An extra 5 percent allowance for optimum activity levels for children specified by FAO/WHO/UNU (1985) is removed (Naiken 2003).

Figure 5.2 FAO log-normal distribution framework



at each acceptable weight-for-height and physical activity level. FAO uses the lowest acceptable requirement, referred to as the *minimum* energy requirement for light activity (corresponding to the fifth percentile of the body mass index).[35] The national dietary energy requirement is a weighted average of the age- and sex-specific minimum requirements using population proportions as weights (Naiken 2003). The aim is to identify individuals who are at a "high" or "unacceptable" risk of food energy deficiency. In this approach, any person falling below the minimum requirement of her or his age–sex group is undoubtedly food energy deficient. However, those who are not meeting their requirement but are still above that of the lowest-weight person in their age–sex group are erroneously classified as not being food energy deficient. Thus, when a minimum requirement is used many food insecure people are missed.

The requirements used in this study are the *average* energy requirements for light activity of each age-sex group, as recommended by the FAO/WHO/UNU (1985) consultation. In contrast to those used by FAO, the aim is to identify people falling below where they *should* be. As discussed in Chapter 2, this also leads to some classification error because the people whose individual requirement is below the average may be wrongly classified as food energy deficient and those whose requirement is above may be wrongly classified as not energy deficient. If the numbers of people in these groups are roughly the same, the errors will cancel each other out and not influence the calculation of the percentage of a population that is food energy deficient (Mason 2003). However, further research is needed to determine the bias entailed, if any.

Table 5.2 compares HES and FAO estimates of national dietary energy requirements. HES estimates are calculated as the average person's energy requirement in each survey's sample, corrected for the sampling design. The mean of the FAO requirements across the countries is 1,808 kilocalories, ranging from 1,720 for Ethiopia to 1,890

[35]Note that for children below 10 years, the median of the range of weight-for-height is used rather than the lower limit because a range was not specified for this group. The requirements are currently under review based on the 2001 Expert Consultation on Human Energy (FAO 2004a).

Table 5.2 Comparison of HES and FAO estimates of national per capita dietary energy requirement (kilocalories · person^{-1} · day^{-1})

Country	Year	HES	FAO	Difference
Mozambique	1996	2,048	1,890	158
Guinea	1994	2,026	1,830	196
Ghana	1998	2,058	1,850	208
Senegal	2001	2,066	1,850	216
Zambia	1996	2,042	1,820	222
Tanzania	2000	2,035	1,810	225
Burundi	1998	2,025	1,790	235
Kenya	1997	2,069	1,820	249
Malawi	1997	2,060	1,800	260
Uganda	1999	2,039	1,770	269
Rwanda	2000	2,043	1,750	293
Ethiopia	1999	2,035	1,720	315
Mean		2,046	1,808	237

Notes: HES estimates are calculated as the average of each sample individual's energy requirement.
FAO estimates are from FAO (2005a).

for Mozambique. The mean of the HES requirements is 2,046—237 kilocalories higher than the FAO estimate.

Comparison of Mean Dietary Energy Consumption

The mean of the log-normal distribution for any year used in the FAO approach is estimated as countries' DESs in kilocalories per capita during the year. It is derived from food balance sheets compiled annually by FAO using data on the production and trade of food. The quantities of foods available for human consumption are calculated after the use for seed and animal feed, wastage rates, and stock changes are taken into account. The estimated energy available per person is then obtained by converting the values to their dietary energy content and dividing by the population size.

Recall that, as discussed in Chapter 2, the data collected in HESs generate estimates of mean household dietary energy availability that are unbiased estimates of mean dietary energy consumption. Thus, the FAO and HES estimates should theoretically be quite close.

Table 5.3 compares FAO and HES estimates of national per capita dietary energy consumption, with the countries ordered by the magnitude of the difference. The HES estimates are calculated as the survey design–corrected mean of the energy available to each person in the sample, which itself is estimated as the per capita energy availability of each person's household. Although the average difference (last column) is quite small, at 40 kilocalories, many of the country differences are substantial, the largest being for Kenya (598 kilocalories), Tanzania (496 kilocalories), and Malawi (–433 kilocalories). The only country for which little disparity was found is Burundi. No consistent pattern in the direction of the difference can be detected: for roughly half of the countries for which there is a substantial difference it is negative, and for the other half it is positive.

One explanation that has been given for the difference in FAO and HES estimates of the energy available for human consumption is that food balance sheets measure it at a completely different level of the food system, including nonhousehold use (FAO

Table 5.3 Comparison of HES and FAO estimates of national per capita dietary energy consumption (kilocalories · person^{-1} · day^{-1})

Country	Year	HES estimate	FAO estimate	Difference
Malawi	1997	1,614	2,047	–433
Senegal	2001	1,967	2,277	–310
Rwanda	2000	1,860	2,058	–198
Ghana	1998	2,328	2,525	–197
Zambia	1996	1,764	1,958	–194
Ethiopia	1999	1,648	1,801	–153
Burundi	1998	1,592	1,628	–36
Mozambique	1996	2,059	1,826	233
Uganda	1999	2,636	2,334	302
Guinea	1994	2,510	2,194	316
Tanzania	2000	2,454	1,958	496
Kenya	1997	2,579	1,981	598
Mean		2,089	2,049	35

Note: HES estimates are calculated as the average of each sample individual's calorie availability, which is approximated as the calorie availability per capita of the individual's household. FAO estimates are from the on-line FAOSTAT database (FAO 2003).

1983).[36] If this were the case, however, a common pattern of higher estimates from food balance sheets would be apparent. Dowler and Seo (1985) discuss issues of food wastage at the household level, comparability of time periods, and discrepancies over the definition of "food."

Others point to the challenges of measuring countries' food supplies, leading to inaccuracies in the FAO estimates. Svedberg (1999) gives two main reasons for the large margins of error in agricultural production and trade estimates for Sub-Saharan Africa (for example from 25 to 46 percent, cited in Blades 1980). The first is that the food production system is highly complex, with subsistence production dominating, mixed or relay cropping common, and the number of minor crops relatively large. The second is that primitive estimation methods are used, mainly ocular observation by extension officials, and in many cases no field-based method at all. Gillen (2004) reports that the basic data from some countries are incomplete and inaccurate, with subsistence production usually not included. Writes Naiken (2003, p. 23): "the per capita DES estimates resulting from the ratio of total food supply to population are subject to significant errors, particularly where the data problems are severe, for example in Africa."

Comparison of the Coefficients of Variation (CV) of Dietary Energy Consumption Used by FAO with HES Estimates of the CV of Dietary Energy Availability

It is important to recall that FAO CVs refer to the distribution of dietary energy *consumption,* whereas those derived from HES data describe the distribution of dietary energy availability. Thus, we do not expect them to be of similar magnitude. As discussed in Chapter 2, the distribution of energy availability is likely to be flatter and have a wider range than that of energy consumption, as the

[36] See Ravallion (2001) and Deaton (2003) for a similar discussion of differences in estimates of poverty from national income accounts and household surveys and the possible reasons for them.

latter conforms to human biological energy intake limits. Its CV is thus expected to be higher.

The main source of distributional data from which estimation of FAO CVs starts is HES data on household per capita calorie availability. FAO has determined that "considerable problems are encountered in using such data for estimating the distribution of dietary energy consumption" (Naiken 2003, p. 11). The reliability issues discussed in Chapter 2 are raised, for example, measurement errors caused by recall bias, the inclusion of food given to guests and visitors and waste, the difficulties of determining the energy content of food consumed away from home, and the use of shorter-than-annual reference periods for food data collection, which can inflate variability in the data.

To overcome the above problems, mean household energy availability per capita for large groups of households classified by household per capita income (or total expenditure) is used. Such a method is believed to provide reliable estimates of annual average consumption to calculate the "CV of household per capita usual dietary energy consumption owing to income." A factor of 0.2 is added to account for the variation in dietary energy requirements. However, for the majority of countries, the data for estimating the CV owing to income are not available. When the data are not available, two other techniques are used. When only data on income distribution are available, the parameter describing the distribution of dietary energy is estimated using a cross-country regression with per capita Gross Domestic Product as the predictor. For countries for which no distributional data are available at all, the CVs are predicted using data on infant mortality rates (Naiken 2003).

Finally, a limit is set on the possible minimum and maximum CV of 0.2 to 0.35. This range is based on the standard deviation of the energy requirement distribution of a hypothetical well-fed population (660 kilocalories) and the highest and lowest developing-country dietary energy supplies per capita (1,900 and 3,400). It is supported by an analysis of variance of data from household food consumption surveys conducted for small, rural, homogeneous populations of Bangladesh, Kenya, Pakistan, Philippines, and Zambia.[37] Note that an analysis conducted by FAO shows that the CV in this range makes little difference to the estimates of food energy deficiency (FAO 1996).

There is some reason to believe that the FAO CVs may be biased downward, for the following reasons. The true variability of food consumption found in developing countries, where many people fall below their energy requirements and more and more are falling above, is likely to be higher than that of a group of people who are just meeting their requirements. Further, the national CVs for entire countries are likely to be higher than those found in a relatively homogeneous subnational population (Smith 1998a).

Table 5.4 reports energy availability CVs derived from the HES data sets[38] and energy consumption CVs used in the FAO computations. Note that it is not possible to correct for the sampling design in estimating the standard deviation from HESs, and thus the CV. The HES-derived CVs presented here are thus not design unbiased.[39] They range from a low of 0.39 for Ethiopia to a high of

[37]These surveys, conducted by IFPRI, are described in more detail in Chapter 2.

[38]Although they are based on mean *household* energy availability per capita and its standard deviation, when individual data are used roughly the same estimates are obtained.

[39]This does not place any limitation on the estimation of food energy deficiency prevalences using the nonparametric approach of this report, however, in which a sampling design–corrected proportion is calculated directly from the data without the need for estimating a CV first (as is necessary in the parametric approach).

Table 5.4 Comparison of HES estimates of coefficient of variation (CV) of dietary energy availability with FAO estimates of CV of dietary energy consumption

Country	Year	HES estimate (energy availability)	FAO estimate (energy consumption)	Difference
Ethiopia	1999	0.39	0.32	0.07
Uganda	1999	0.52	0.29	0.23
Senegal	2001	0.56	0.26	0.30
Tanzania	2000	0.57	0.28	0.29
Guinea	1994	0.58	0.33	0.25
Kenya	1997	0.62	0.26	0.36
Ghana	1998	0.62	0.27	0.35
Rwanda	2000	0.66	0.32	0.34
Mozambique	1996	0.70	0.31	0.39
Zambia	1996	0.73	0.30	0.43
Burundi	1998	0.75	0.29	0.46
Malawi	1997	0.79	0.32	0.47
Mean		0.62	0.30	0.32

Notes: HES estimates are calculated as the standard deviation of household per capita dietary energy availability divided by its mean.
FAO estimates are from FAO (2005b).

0.79 for Malawi. Ethiopia is an extreme case. Most of the CVs lie in a range from 0.50 to 0.75, far outside that assumed for the FAO method.

Contribution of the Parameter Differences to Divergences between FAO and HES Estimates of Food Energy Deficiency

In this section an analysis is undertaken to determine the relative contributions of the parameter differences described above to the divergences between FAO and HES estimates of food energy deficiency. The three parameters used for the FAO method are replaced, one by one and in combination, with those derived from the HES data (or, in the case of the energy requirement, assumed for the HES method). The FAO estimates of food energy deficiency are then recalculated to determine whether and by how much the divergence from the HES estimates is reduced.

Three measures of divergence between the FAO and HES estimates are employed:

- The difference in the mean of the food energy deficiency estimates across the 12 countries
- The mean of the absolute-value differences in food energy deficiency across the countries
- Correlation between the estimates

The first is the simple difference in the mean energy deficiency prevalence yielded by the two methods across the countries. Although informative, this measure may mask the extent of the divergence between the estimates as positive differences cancel out negative ones. The second measure overcomes this problem. The difference is calculated for each country first, and then the average of the absolute values of the differences is taken. The third measure allows an examination of the association between the two sets of estimates, giving us a better understanding of the differences in country rankings. If the correlation coefficient is equal to 1, then the estimates are essentially giving us the same information when it comes to country rankings, even if their magnitudes are different.

Table 5.5 presents the results of this analysis. In Figure 5.3 the simulated FAO estimates of food energy deficiency for each

Table 5.5 Differences and correlations between FAO and HES estimates of food energy deficiency when FAO estimates are recalculated using HES parameters

		Recalculation of FAO estimates using:					
					HES requirement and		
Measure	Original FAO estimates (1)	HES requirement (2)	HES mean dietary energy consumption (3)	HES coefficient of variation (4)	Mean dietary energy consumption (5)	Coefficient of variation (6)	All HES parameters (7)
Difference between HES and FAO estimate means across countries (percentage points)	19.5	2.8	18.3	6.0	4.4	–2.7	–1.6
Mean of country-level absolute value differences between HES and FAO estimates (percentage points)	20.0	11.7	18.3	10.9	9.4	9.0	1.7
Pearson correlation coefficient between HES and FAO estimates	0.456	0.558	0.981	0.569	0.987	0.643	0.997
	(P = 0.136)	(P = 0.059)	(P = 0.000)	(P = 0.054)	(P = 0.000)	(P = 0.024)	(P = 0.000)

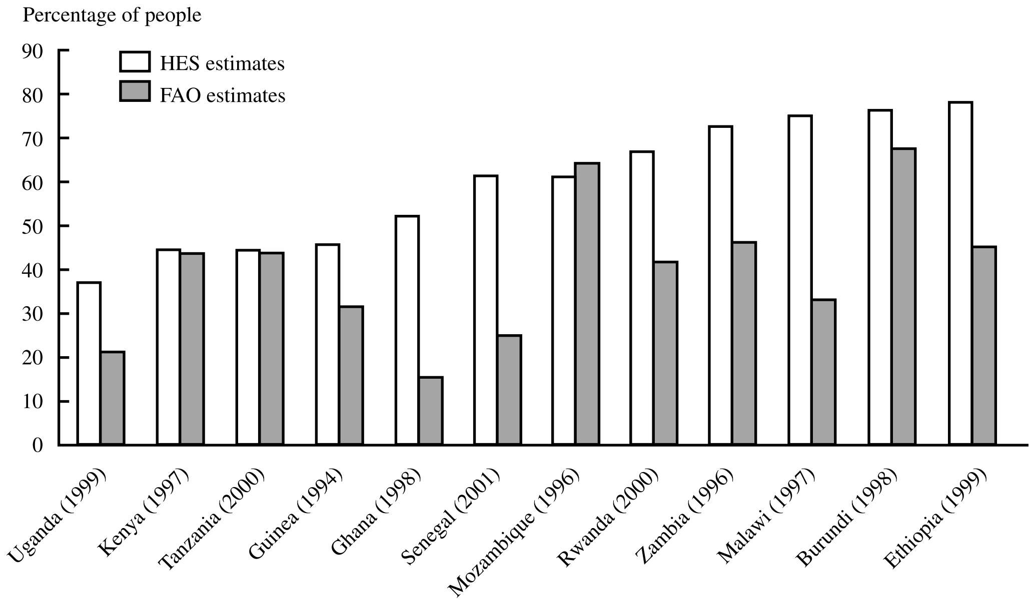
country are compared with the HES estimates under the various parameterizations. The baseline difference between the means of the HES and FAO estimates is 19.5 percentage points (58.5% vs. 39%) (Table 5.5, column 1 and Fig. 5.3A). The mean of the absolute value differences across the 12 countries is 20. The correlation coefficient is 0.46 and is not statistically significant.

When the FAO estimates are recalculated using the average energy requirements for light activity assumed for the HES method instead of the minimum requirements, they increase substantially (Fig. 5.3B). The mean food energy deficiency prevalence rises from 39 percent to 56 percent, giving a difference in means of 2.8 percentage points (Table 5.5, column 2). Concurrently, the mean absolute value difference between the HES and FAO estimates drops from 20 to 11.7 percentage points. Further, the correlation between the estimates rises from 0.46 to 0.56, becoming statistically significant at the 10 percent level. We can thus conclude that some of the country-level differences between the HES and FAO estimates can be attributed to the use of a lower set of dietary energy requirements for the latter, which lowers the percentage of people considered to be food energy deficient. It is important to note, however, that quite a large divergence remains, with the differences between the estimates being far from zero and their correlation far from perfect. This means that much of the divergence remains to be explained by differences in the other two parameters.

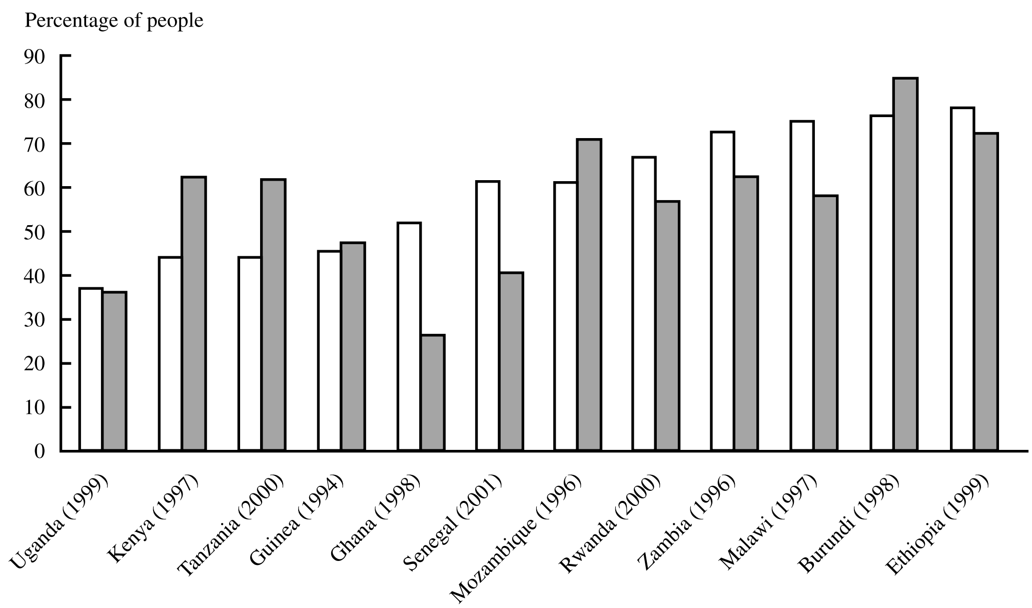
In regard to mean dietary energy consumption, column 3 of Table 5.5 shows that the major HES–FAO differences in this parameter described above (see Table 5.1) translate into a large contribution to divergences in estimates of food energy availability. When the original FAO parameter is replaced with that derived from HESs, there is only a slight reduction in the mean differences measures. However, the correlation between the FAO and HES estimates rises from 0.46 to 0.98, or almost 1.0. These re-

Figure 5.3 Comparison of HES and FAO estimates of national prevalences of food energy deficiency when FAO estimates are recalculated using HES parameters

A. Baseline estimates



B. FAO estimates with HES requirement

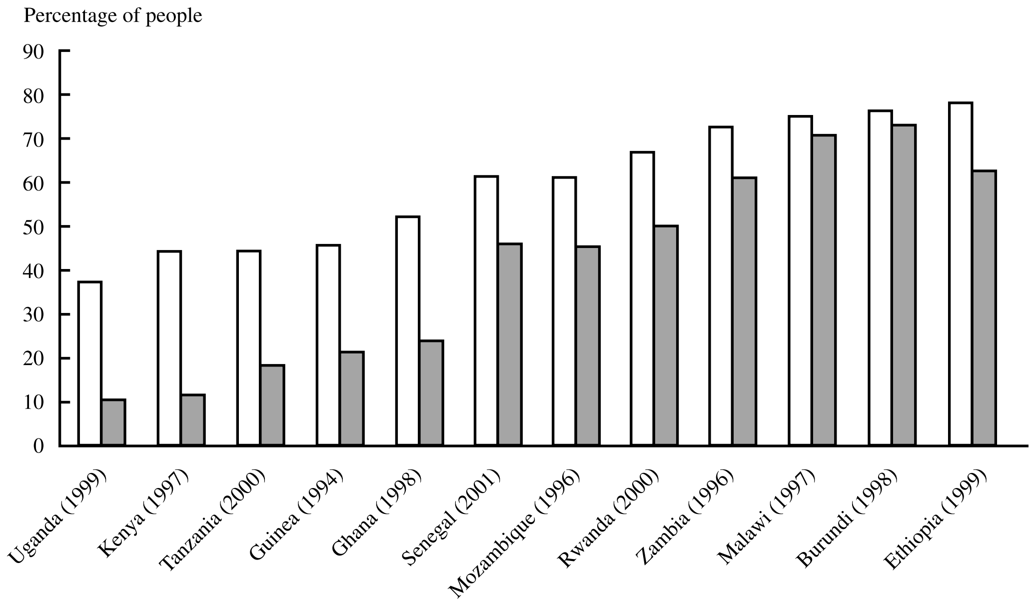


(continued)

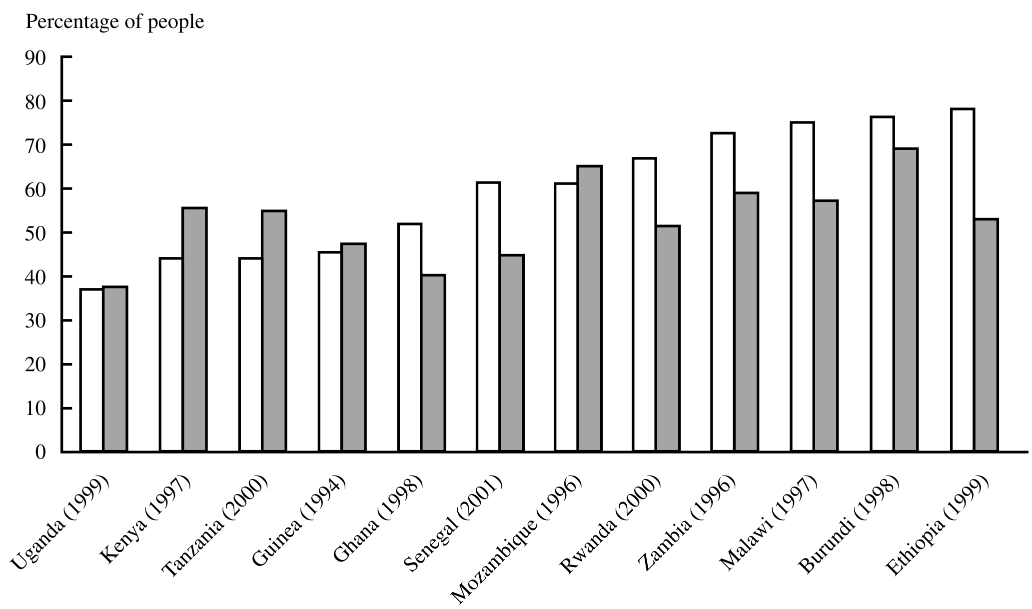
sults imply that a large part of the divergences between the food energy deficiency estimates generated by the two methods can be attributed to substantial differences in the underlying data used to represent dietary energy consumption of countries' populations. Note that, as can be seen from Figure 5.3C, under this scenario the country rankings are quite close, the only difference being that the rankings of Senegal and

Figure 5.3—Continued

C. FAO estimates with HES mean dietary energy consumption



D. FAO estimates with HES coefficient of variation in dietary energy availability



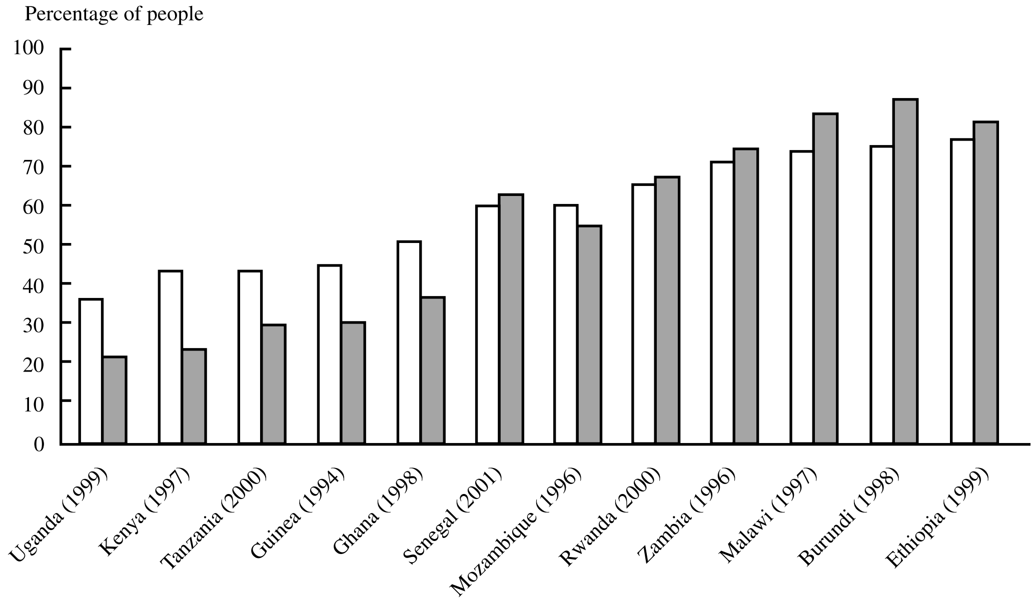
Mozambique, and of Burundi and Ethiopia, are reversed.

With respect to the third parameter, the CV, when the FAO estimates of this parameter are replaced with those derived from HESs, FAO estimates of food energy deficiency increase for all 12 of the study countries. The mean absolute value difference between the FAO and HES estimates decreases from 20 to 10.9 percentage points; their correlation increases somewhat, from 0.46 to 0.57 (Table 5.5, column 4).

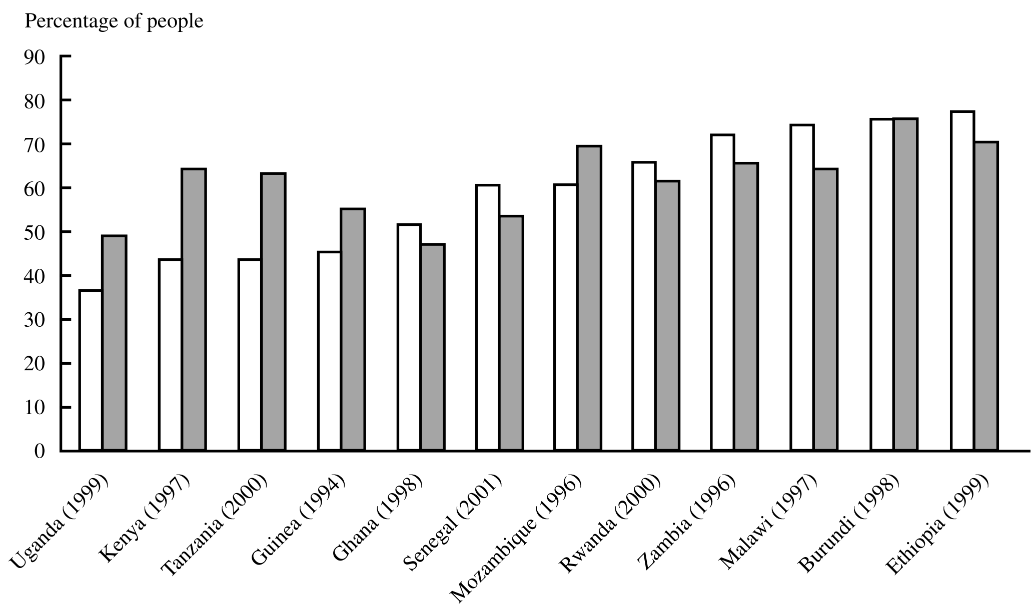
We can learn more about the relative contributions of the mean and CV by assum-

Figure 5.3—Continued

E. FAO estimates with HES requirement and mean dietary energy consumption



F. FAO estimates with HES requirement and coefficient of variation in dietary energy availability

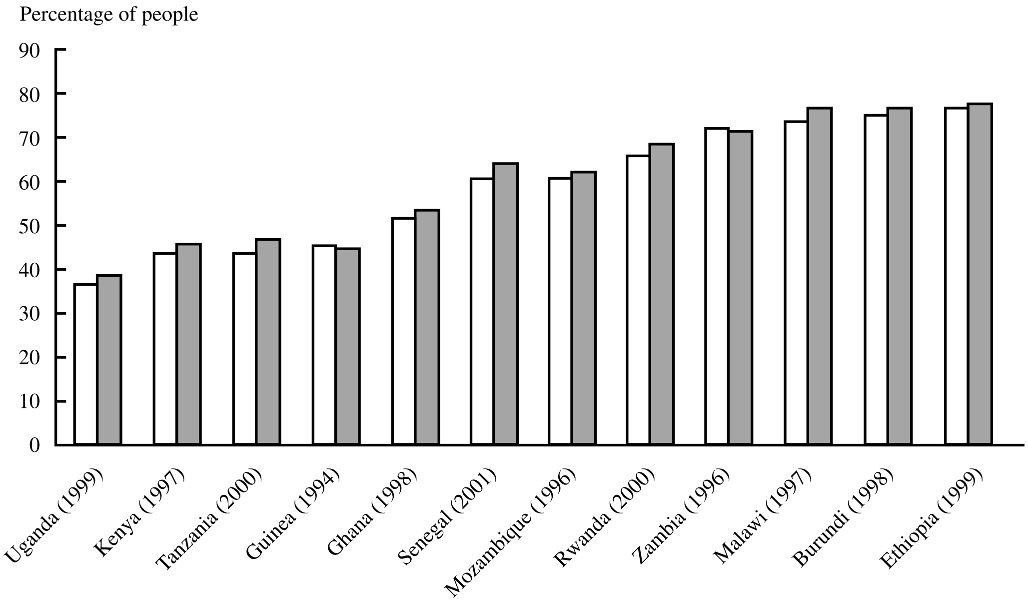


(continued)

ing that the energy requirements are the same (the average requirement) and then seeing what happens when these two other parameters are replaced, one at a time, by their HES equivalents. This is an interesting experiment in that the requirements are assumed, whereas the other parameters are estimated using different methods and data. Column 5 of Table 5.5 (and Fig. 5.3E) shows what happens when the FAO estimates are

Figure 5.3—Continued

G. FAO estimates with all HES parameters



recalculated using the HES requirements and mean dietary energy consumption. Column 6 (and Fig. 5.3F) shows what happens when they are recalculated using the HES requirements and CV. The mean absolute-value difference between the HES and FAO estimates of food energy deficiency falls by about 9 points from the baseline in both cases. But when the requirement and mean are the same, the correlation rises to 0.99 compared to only 0.643 when the requirement and CV are the same. This confirms that the mean dietary energy consumption per capita plays a much more significant role in the divergences between FAO and HES estimates of food energy deficiency than does the CV.

Finally, we can gain some insight into whether the use of the parametric log-normal probability distribution framework is itself contributing to divergences in the estimates of food energy deficiency. When HES estimates of all three parameters associated with the FAO method are applied to the log-normal probability distribution framework, roughly the same estimates are derived as when the survey data are used directly (see also Aduayom and Smith 2003). The mean absolute value difference between the estimates falls from 20 to 1.7 percentage points, and their correlation rises to just slightly under 1.0. The largest difference is for Senegal, for where the HES prevalence of food energy deficiency based directly on the survey data of 60.2 percent rises to 64.0 percent when the distribution model is used instead. Further, the empirical probability distributions of per capita dietary energy availability across households for the study countries all indeed show a consistent log-normal shape, that is, skewed to the right.[40] This can be seen from the nonparametric

[40]Note, however, that the distributions do not pass statistical tests for log-normality. In particular, when the "sk-test" command is used in STATA, the test rejects the hypothesis that the distribution of the log of calories per capita is normal, with adjusted Chi-squared test values ranging from 46 (for Ethiopia) to 3,907 (for Malawi).

Table 5.6 Poverty and child malnutrition prevalences for study countries

Country	Year	Poverty (< US$1 per day) (%)	Child malnutrition (underweight) (%)
Burundi	1998	58.4	45.1
Ethiopia	1999	81.9	47.2
Ghana	1998	44.8	24.9
Guinea	1994		
Kenya	1997	23.0	22.1
Malawi	1997	41.7	29.6
Mozambique	1996	37.9	26.1
Rwanda	2000		24.3
Senegal	2001		22.7
Tanzania	2000		29.4
Uganda	1999		22.8
Zambia	1996	63.7	23.5

Notes: Poverty estimates are from World Bank (2003). Child malnutrition estimates are from WHO (2003). They are from surveys undertaken within 2 years of the HES surveys under study in this report.

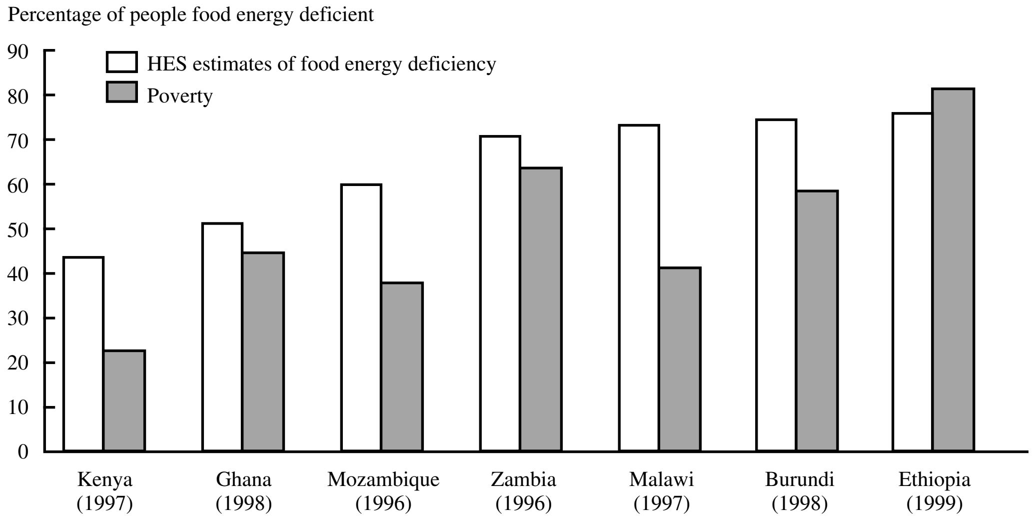
probability density functions of Figure 3.2 in Chapter 3 and indicates that the distribution of calorie consumption are log-normal as well. These findings suggest that use of a theoretical probability distribution framework in general, and of the log-normal assumption in particular, is not a major factor driving the discrepancies in the HES and FAO estimates of food energy deficiency.

In sum, the analysis of this section has shown that it is not the FAO method itself that underlies divergences in the FAO and HES estimates of food energy deficiency but instead differences in the underlying parameters used. The mean of the absolute-value differences across the countries is a summary measure of the distance between the two estimates in terms of direct comparisons of levels. From this perspective the difference is reduced the most, but only by just over half, when the CVs and energy requirements are the same. The correlation coefficient is a summary measure of the degree of association between the two measures. The concern here is with both levels and country rankings, which are equally important for policy purposes. The correlation between the measures under the different parameterizations (first three scenarios) rises the most when mean household dietary energy consumption is equalized, almost to 100 percent agreement. It rises only slightly when the energy requirements and CVs are equalized. This suggests that the most important factors underlying the differences between HES and FAO estimates of food energy deficiency for Sub-Saharan African countries are the implied estimates of food consumption in countries.

Comparison of HES and FAO Estimates with Poverty and Child Malnutrition

One way to determine whether HES data can be used to improve the accuracy of FAO estimates of food energy deficiency is to investigate how both compare to other indicators that are related to food security and that are widely believed to be accurately measured. Table 5.6 gives estimates of poverty, which is a primary determinant of food security, and child malnutrition, of which food security is in turn a major determinant, for the countries and time periods for which they are available. Both of these measures are

Figure 5.4 Comparison of HES estimates of national prevalences of food energy deficiency with poverty



Source: See Table 6.3.

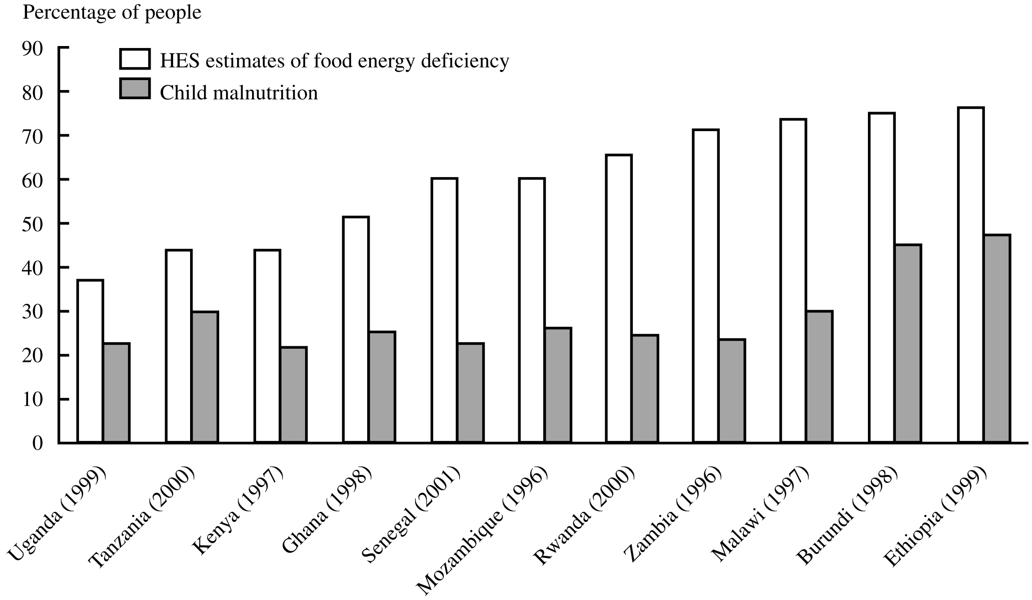
conceptually close to, yet still distinct from, food insecurity (see Fig. 2.1 in Chapter 2). Thus, although we would expect some positive correlation between them and a measure of food insecurity, we would not expect an exact correlation. The poverty estimates are reported by the World Bank (2003) and represent the percentage of countries' populations that live on less than US$1 per day. They are available for only seven of the countries. Note that some of the correlation between the poverty and food energy deficiency estimates can be attributed to the use of the same data sources as well as to conceptual closeness of the indicators. The child malnutrition estimates are from WHO (2003) and represent the percentage of children less than 5 years old who are underweight for their age. They are available for all countries except Guinea. Figure 5.4 compares the HES food energy deficiency and poverty estimates. Their Pearson correlation coefficient, reported in Table 5.6, is 0.78 ($P = 0.039$). Figure 5.5 compares the HES food energy deficiency and child malnutrition prevalences. Here the association is less strong, but still significant. The Pearson correlation coefficient is 0.60 ($P = 0.053$).

Table 5.7 also gives correlation coefficients between poverty and child malnutrition and FAO estimates of food energy deficiency prevalence. The Pearson correlation, at 0.12, is far lower than that for the HES estimates and is not statistically significant. The child malnutrition correlation, also statistically insignificant, is somewhat lower than the HES correlation. Spearman rank correlations are also given in Table 5.7. Here the divergence between the correlations with child malnutrition is greater, with that for the HES estimates being 0.68 ($P = 0.022$) and that for the FAO estimates being 0.41 and not significant. Evidently, the HES estimates are more strongly associated with poverty and child malnutrition when it comes to both magnitudes and country rankings.

Comparison of HES and FAO Estimates with Country Rankings from a Survey of Expert Opinion

There is no gold standard with which to judge the accuracy of estimates of food energy deficiency. However, a potentially useful way to judge them is to rely on the

Figure 5.5 Comparison of HES estimates of national prevalences of food energy deficiency with child malnutrition



Source: See Table 5.6.

knowledge and experience of people who are considered to be experts in the area of food insecurity in our region of interest, Sub-Saharan Africa. With this in mind, a group of 83 people considered to be experts in the area of food security were asked to rank the 12 study countries on the severity of food insecurity in order to determine if (1) there is any general agreement as to the rankings of the countries and (2) how the rankings compare with those generated from the FAO and HES estimates. The survey took place by e-mail from June to September 2004. The questionnaire is presented in Box 5.1. Note that the respondents were not given a specific definition of food security and were asked to base their responses on their own knowledge and experience rather than any published statistics. Of the polled experts, 30 (36 percent) responded and

Table 5.7 Correlations between estimates of food energy deficiency and poverty and child malnutrition

Statistic	HES food energy deficiency	FAO food energy deficiency
Pearson correlations		
Poverty	0.78	0.12
	(*P* = 0.039)	(*P* = 0.796)
Child malnutrition	0.60	0.48
	(*P* = 0.053)	(*P* = 0.133)
Spearman rank correlations		
Poverty	0.75	0.21
	(*P* = 0.052)	(*P* = 0.645)
Child malnutrition	0.68	0.41
	(*P* = 0.022)	(*P* = 0.205)

Box 5.1 Expert Opinion Survey on Food Insecurity in Study Countries: Questionnaire

Greetings,

You have been referred to me as a person who has broad knowledge of the food security situation in Sub-Saharan African countries. Could you take a few moments to rank the following 12 countries on the severity of food insecurity in the mid- to late 1990s (starting with most severe to least severe food insecurity)? Please base your ranking on your own knowledge and experience.

Feel free to leave out countries and make qualifying comments at your discretion.

Burundi
Ethiopia
Ghana
Guinea
Kenya
Malawi
Mozambique
Rwanda
Senegal
Tanzania
Uganda
Zambia

Thank you for your time. If you have suggestions of others who could undertake this ranking, I would appreciate your sending me their names.

Lisa Smith
Research Fellow
International Food Policy Research Institute

ranked the countries. Nine refused to rank the countries, and 46 did not respond. The institutional affiliations of the respondents are as follows:

- Nongovernmental development assistance agencies (4)
- Governmental development assistance and United Nations agencies (3)
- Development technical assistance agencies (6)
- Research and academia (15)
- Foundations (2)

An average rank score based on the responses was calculated for each country, resulting in the ranking presented in Table 5.8.[41] To get a sense of whether the respondents agreed with one another, the table reports the number who rated each country 1, 2, and so forth. The number of respondents who ranked the country in the final mean rank position is highlighted along the matrix diagonal. In no case did all of the respondents rank a country the same. At the extremes of the final rank (ranks 1, 2, 3, and

[41] Six respondents ranked fewer than 12 countries (from 8 to 11) citing insufficient personal knowledge about the omitted countries. In order to render these respondents' responses comparable to the others, their raw scores were adjusted by multiplying the given rank by a factor of 12 divided by the number of countries ranked before computing the average rank score for all respondents.

Table 5.8 Expert opinion survey: Respondent rankings

Country	Average rank	Respondent rankings 1	2	3	4	5	6	7	8	9	10	11	12	Number of rankings
Ethiopia	1	21	5	2	1			1						30
Malawi	2	1	15	6	2	1	1	1	2					29
Burundi	3	2	4	6	3	3	5	3	3	1				30
Mozambique	4		3	8	4	6	3	3				2		29
Rwanda	5	2	2	5	6	3	5	3		4				30
Zambia	6		1	3	3	6	3	2	3	2	1	3	1	28
Guinea	7		1	3	2	2	5	3	2	3	3	2		26
Tanzania	8				3	1	3	7	7	1	3	4	1	30
Kenya	9					4	3	2	5	1	8	5	2	30
Senegal	10					3	1	1	2	4	3	7	6	27
Uganda	11			1				2	2	9	3	6	7	30
Ghana	12						1	1	3	2	2	11	8	28

11 and 12), there is generally more agreement than in the middle. Ethiopia is the country for whom there was the most agreement, with 70 percent of respondents ranking it as having the most severe food insecurity.

A kappa test statistic of interrater agreement was calculated for each of the 12 possible ranks and for overall agreement among the respondents (StataCorp 2003). The statistic ranges from 0 to 1, with the following interpretations on the degree of agreement (Landis and Koch 1977):

0	Expected by chance
>0 to 0.20	Slight
0.21–0.40	Fair
0.41–0.60	Moderate
0.61–0.81	Substantial
0.81–1.00	Almost perfect

The only country for which even moderate agreement was found is Ethiopia, for whom the test statistic is 0.526. The rankings for Uganda and Ghana (11 and 12) exhibited "slight" agreement, that for Malawi (2) exhibited "fair" agreement, and the rankings for the remaining countries exhibited "poor" agreement. The overall test statistic is 0.113, signaling only slight agreement. Clearly, the rankings of the experts do not represent a consensus. This could be a result of differing definitions of the concept of food insecurity, different sources of information, different evaluation criteria, variation in temporal frame of reference, and differing degrees of knowledge of the food security situations in the countries.

Table 5.9 compares the average expert opinion survey rankings to those derived from FAO and HES estimates of food energy deficiency. In no case is any one country ranked exactly the same by all three criteria. The countries for which there is the most disagreement are Tanzania and Kenya. The countries for which there is the most agreement are Burundi, Rwanda, Guinea, and Uganda. Note that the FAO estimate rankings are more similar to the experts' ranking at the bottom end of the scale, whereas HES ranks are more similar to them at the top of the scale.

Table 5.10 presents the results of two tests for agreement between the average expert survey ranking on the one hand and the FAO and HES rankings on the other. The Spearman correlation between the expert ranking and the HES ranking is 0.83, whereas that for the FAO ranking

Table 5.9 Expert opinion survey: Comparison of country rankings with those derived from FAO and HES estimates of food energy deficiency

Country	Expert opinion survey ranking	Ranking based on FAO estimates	Ranking based on HES estimates
Ethiopia	1	4	1
Malawi	2	8	3
Burundi	3	1	2
Mozambique	4	2	6
Rwanda	5	7	5
Zambia	6	3	4
Guinea	7	9	9
Tanzania	8	5	10
Kenya	9	6	11
Senegal	10	10	7
Uganda	11	11	12
Ghana	12	12	8

Table 5.10 Expert opinion survey: Tests of association of country rankings with those derived from FAO and HES estimates of food energy deficiency

Statistic	HES food energy deficiency	FAO food energy deficiency
Spearman rank correlation	0.83 ($P = 0.001$)	0.69 ($P = 0.126$)
Kappa test statistic (weighted)	0.58 ($P = 0.001$)	0.45 ($P = 0.007$)

is 0.69, considerably lower. The kappa test statistic is 0.58 for the HES ranking and 0.45 for the FAO ranking.[42] Both of these fall into the "moderate" agreement category, but again, the degree of agreement for the HES estimates is deemed higher. We can conclude that the HES estimates are somewhat more similar to the opinions of the expert survey respondents than the FAO estimates, with the caveat that the experts show a wide range of opinions as to the relative severity of food insecurity across the countries.

[42] These statistics were calculated using a set of factors to weight disagreements differently depending on how far they are from perfect agreement. The weights are calculated as [1 – (difference in ranks)]/(maximum number of possible ratings – 1) (StataCorp 2003). In this specific case, when there is no disagreement, the weight is 1; when the disagreement is by only 1 rank point, the weight is 0.09091; by two rank points 0.8182; and so on. The purpose of this weighting system is to take into account the strength of the disagreements (for example *how* far apart the expert and HES rankings are), with greater disagreements being reflected in a lower test statistic.

CHAPTER 6

Evidence on Cross-Country Comparability and Other Reliability Issues

Cross-Country Comparability

The data cleaning, processing, and computation protocols employed for this research are standard for all countries (see Chapter 3). However, differences in data collection methodologies raise some issues of cross-country comparability. In this chapter we use the country-level estimates from the surveys used in this report to gain some insights.

Table 6.1 compares the diet quantity and quality estimates across groups of the surveyed countries with similar data collection methods on the following characteristics:

- Recall period (less or greater than 1 week)
- Reference period (1–2 weeks versus 2 weeks to 1 month versus 1 month)
- Number of food items for which data were collected (less or greater than 110)
- Means of data collection (interview or diary)
- Whether in-kind food acquisitions are included

These characteristics are specified for each country in Table 3.2 in Chapter 3.

With respect to the first characteristic, the recall period, the discussion in Chapter 2 pointed to the possibility that a longer recall period would lead to a greater chance of recall bias, that is, lower reporting of food quantities or expenditures because of memory failure. On the other hand, a shorter recall period may lead to telescoping, where the respondent includes events that occur before the recall period, thus inflating estimates of food acquisition. In the case of the diet quantity measures, Table 6.1 shows little difference across the groups of countries with a recall period less than 1 week and greater than 1 week. The difference in energy availability per capita is 83 kilocalories; the difference in the percentage of people food energy deficient is 2.8 percentage points. Both differences are not statistically significant. The moderate differences across the groups for the diet quality measures are not statistically significant.

The length of the survey reference period also appears to make little difference for the diet quantity measures. In particular, the issue raised in Chapter 2 that the length of the reference period influences the dispersion of energy availability and thus the percentage food energy deficient does not seem to be a major problem. Although the dispersion is indeed smaller the longer is the reference period (the CV drops from 0.7 to 0.6 and then 0.5 across the groups), it is apparently not enough to influence the percentage food energy deficient.

The figures reported in Table 6.1 indicate that the reference period may matter, however, for the diet quality measures. As discussed in Chapter 3, the longer the reference period the more variety is picked up simply because people are likely to acquire a wider variety of foods with the passage of more time. The diet diversity score is 4.6 for the group of countries with

Table 6.1 Food security indicators, by data collection method

Method	Number of countries	Energy availability per capita: Kilocalorie per person per day	Energy availability per capita: Difference	Percentage of people food energy deficient: Percentage	Percentage of people food energy deficient: Difference	Diet diversity: Number of food groups	Diet diversity: Difference	Percentage of households with low diet diversity: Percentage	Percentage of households with low diet diversity: Difference
Recall period									
< 1 week	8	2,061		59.5		5.2		28.9	
≥ 1 week	4	2,144	–82.8	56.7	2.8	4.7	0.5	40.9	–12.0
Reference period[a]									
1–2 weeks	5	2,107		57.8		4.6		46.5	
2 weeks–1 month	4	2,025		60.4		5.3		27.2	
1 month	3	2,143	–36	57.2	0.6	5.5	–0.9***	18.0	28.4**
Number of food items									
< 110	6	2,127		57.2		4.9		36.8	
≥ 110	6	2,050	77	59.9	–2.7	5.2	–0.3	29.1	7.8
Data collection means									
Interview	8	2,082		59.2		4.8		39.9	
Diary/interview	4	2,103	–21.6	57.2	2.0	5.5	–0.7*	18.9	21.0**
Includes in-kind food									
No	4	2,137		57.2		5.1		27.2	
Yes	8	2,065	71.5	59.1	–1.9	5.0	0.1	38.6	–11.4

Note: Asterisks indicate that difference is significant at the 1 (***), 5 (**), or 10 (*) percent levels using a one-tailed two-sample *t*-test.
[a]The difference given is between the first and last groups.

reference periods of 1–2 weeks. It rises to 5.5 for those with reference periods of 1 month. The percentage of households with a low-quality diet falls from 47 percent to 18 percent. Both of these differences are statistically significant.

To investigate this issue further, a 1-week-equivalent adjustment factor was applied to the country-level estimates as follows. First, an Ordinary Least Squares regression equation was run using the data from all households included in the study data sets except Malawi and Zambia (n = 97,292).[43] The dependent variable was the number of food groups, and the main independent variable was the household-specific reference period, which may differ across households in the survey (see Table 3.2).[44] The regression yielded a reference period coefficient of 0.017 (t = 12.7, R^2 = 0.358). For each country the adjustment factor was calculated as the coefficient multiplied by the difference between the number of days in the reference period and 7 (or 1 week).[45] This procedure yielded adjustment factors ranging from 0.1 to 0.4 food groups. This analysis suggests that for all practical purposes the length of the reference period does not pose major problems of cross-country comparability of estimates of diet diversity.

Greater specificity and detail in the delineation of food items in a survey are thought to lead to greater reporting accuracy and higher estimates of food acquisition. The evidence presented in Table 6.1 does not support this supposition. The energy availability per capita of the countries with a large number of food items is only 77 kilocalories greater than that of countries with a low number, and the difference is not statistically significant. The diet quality measures also differ very little across the two groups.

The means of data collection, whether diary or interview, appears to have little effect on the diet quantity measures but may make some difference for diet quality. Diet diversity is higher for the group of countries for which the diary method was employed, by 0.7 food groups, although the difference is not strongly significant. The percentage of households with a low-quality diet is lower by 21 percentage points, but this difference is not statistically significant.

Finally, whether the survey included questions on households' acquisition of in-kind food seems to make little difference to the estimates of the diet quantity and quality measures. For diet quantity, this means that in-kind food adds little to the overall energy available to households. For diet quality, it implies that in-kind food acquisitions do not significantly increase the variety of foods acquired by households.

These initial findings indicate no major problem of comparability across countries of HES estimates of food energy availability, prevalences of food energy deficiency, diet diversity, and prevalences of low diet diversity.

[43]Households from Malawi and Zambia are left out because for these countries the reference period differs for purchased and nonpurchased foods, making it impossible to assign a single reference period to each household.

[44]Other variables controlled for were the number of household adult equivalents, variables representing the age–sex composition of the household, whether it is female headed, age of the household head, whether at least one adult member has a primary or secondary education, country of residence, and urban or rural location. It is especially important to control for the latter because the reference period differs across urban and rural areas for three of the surveys (Guinea, Rwanda, and Senegal).

[45]For the three surveys with differences in the reference period by urban and rural area (Guinea, Rwanda, and Senegal), the adjustment factor is applied to the diet diversity measure separately for the areas, and then the adjusted national measure is calculated as a weighted average of the urban and rural estimates, with the population proportions in each area as weights. For Zambia, the reference period used is 14 days (only maize purchases have the higher reference period of 30 days). For Malawi, the reference period used is 12 days, which is the average household-level reference period over all food acquisitions, whether purchased or nonpurchased.

Table 6.2 Comparison of national prevalences of food energy deficiency estimated with energy requirements applied at the household and national levels

Country	Year	Energy requirements applied at the household level (%)	Energy requirements applied at the national level (%)	Difference (percentage points)
Ethiopia	1999	76.4	77	–0.6
Burundi	1998	74.8	76	–1.2
Malawi	1997	73.3	76	–2.7
Zambia	1996	71.1	71	0.1
Rwanda	2000	65.3	68	–2.7
Mozambique	1996	60.3	62	–1.7
Senegal	2001	60.2	64	–3.8
Ghana	1998	51.4	53	–1.6
Guinea	1994	45.1	45	0.1
Kenya	1997	43.9	46	–2.1
Tanzania	2000	43.9	47	–3.1
Uganda	1999	36.8	39	–2.2
Mean		58.5	60.2	–1.7

Note: Estimates using energy requirements applied at the household level are from Table 4.1. Estimates using energy requirements applied at the national level are simulated assuming the log-normal probability distribution model.

The Appropriateness of Applying Energy Requirements at the Household Level

The dietary energy requirements reported in FAO/WHO/UNU (1985) and used in this report refer to the average requirements for people of different age and sex groups performing light activity. As discussed in Chapter 2, there is a range of requirements consistent with good health and this activity level within an age–sex group, depending on individuals' body weights, genetic makeup, and so on. Thus, it is inappropriate to apply the requirements to any particular individual to judge whether she or he is consuming adequate dietary energy. By inference, it is also inappropriate to apply the requirements at the household level. Thus, the requirements are recommended to be applied to population groups rather than individuals or households. Yet with the nonparametric method of this report, they are applied directly at the household level before an estimate is made of the percentage of people who are food energy deficient in a country. This raises concern about the reliability of the estimates generating using this method.

To investigate whether the method is valid for estimating national food energy deficiency prevalences given the above concern, we can compare the prevalences generated with those generated using the log-normal probability distribution model (see Chapter 5), for which a requirement can be applied at the population group level. The mean and coefficient of variation (CV) derived from the HES data (see Tables 5.3 and 5.4) and the national per capita dietary energy requirements given in Table 5.2 are applied. Table 6.2 compares food energy deficiency prevalences derived using the two approaches for the 12 study countries. The mean difference between the estimates is –1.7 percentage points, signaling a slight tendency for the prevalence to be lower when the requirement is applied at the household level. However, the difference is minimal,

Table 6.3 Prevalences of food energy deficiency at alternative coefficients of variation of dietary energy availability per capita

	HES prevalence of food energy deficiency (A)				Percent difference from original prevalence (B)			Country rankings (C)			
Country	Original	10% lower CV	20% lower CV	30% lower CV	10% lower CV	20% lower CV	30% lower CV	Original	10% lower CV	20% lower CV	30% lower CV
Uganda	36.8	36	34	32	1.0	8.1	15.8	1	1	1	1
Tanzania	43.9	44	42	41	-1.2	3.3	8.0	2	2	3	4
Kenya	43.9	44	42	40	0.3	5.3	10.5	3	3	4	3
Guinea	45.1	43	41	39	5.7	11.1	16.8	4	4	2	2
Ghana	51.4	51	50	48	0.6	3.6	6.7	5	5	5	5
Senegal	60.2	63	63	63	–5.0	–4.5	–4.1	6	7	7	7
Mozambique	60.3	61	60	60	–1.3	0.0	1.3	7	6	6	6
Rwanda	65.3	67	67	67	–2.9	–2.5	–2.3	8	8	8	8
Zambia	71.1	71	71	71	0.6	0.7	0.7	9	9	9	9
Malawi	73.3	76	76	76	–3.3	–3.6	–3.9	10	10	10	10
Burundi	74.8	76	76	76	–1.3	–1.6	–2.0	11	11	11	11
Ethiopia	76.4	78	80	81	–2.5	–3.9	–5.3	12	12	12	12
Mean	58.5	59.2	58.4	57.7							

with the largest being –3.8 percentage points for Senegal. These results suggest that application of the energy requirements at the household level is not an obstacle to estimating national prevalences of food energy deficiency using the nonparametric approach followed in this report.

Sensitivity of Estimates of Food Energy Deficiency to the Coefficient of Variation

In Chapter 2, the possibility was discussed that CVs of dietary energy availability estimated using HES data are upward biased, thus biasing estimates of food energy deficiency. The reasons for the bias are (1) the inevitable presence of nonsampling errors in the collection and processing of the data and (2) the cost-saving use of reference periods shorter than 1 year. Given the data at hand, we cannot determine the magnitude of this bias. However, we can explore whether the CV has a large effect on food energy deficiency estimates and country rankings. If not, then the problem of upwardly biased CVs is not of major concern.

To do so we calculate the prevalence of food energy deficiency at alternative CVs, starting with the original CVs, progressing to a 10 percent lower CV, a 20 percent lower CV, and then a 30 percent lower CV, again using the log-normal probability distribution model. The estimates of food energy deficiency are simulated using the log-normal distribution framework employed above. Panel A of Table 6.3 gives the estimates under the different scenarios, panel B the percentage difference from the original estimates, and panel C the country rankings.

At a 10 percent lower CV, the estimates of food energy deficiency change very little, with the percentage difference from the original estimates being the highest for Guinea, at 5.7 percent, and the country rankings changing (by 1 point) for only two countries, Senegal and Mozambique. At a 20 percent lower CV, the changes are somewhat greater. At a 30 percent lower CV, some fairly substantial changes begin to appear, with Uganda and Guinea exhibiting the largest differences from the original estimates, at 15.8 percent and 16.8 percent, respectively. The country rankings stay the same for eight of the countries, but for Senegal and Mozambique they change by 1 point, and for Tanzania and Guinea they change by 2 points.

From this analysis we conclude that the issue of increased variability in estimates of household calorie availability per capita derived from HESs as a result of nonsampling errors and short reference periods would be a major concern only if variability, as measured by the coefficient of variation, were to be upwardly biased by at least 30 percent.

CHAPTER 7

Conclusion

This report has used household expenditure survey (HES) data sets from 12 Sub-Saharan African countries to reach three objectives. The first is to explore the extent and location of food insecurity within and across the countries. The second is to investigate the scientific merit of using the food data collected in HESs to measure food insecurity. The third is to compare food energy deficiency estimates generated using HES data with those reported by FAO and begin to explore the reasons for the differences between the two. The study uses both a diet quantity and a diet quality measure of food insecurity. These are (1) the percentage of people who consume insufficient dietary energy, or the prevalence of "food energy deficiency," and (2) the percentage of households with low diet diversity, an indicator of poor diet quality. A household is considered to have low diet diversity if it fails to acquire foods from at least four of seven groups that are sources of essential nutrients for human nutritional well-being.

Research Findings and Policy Implications

Extent and Location of Food Insecurity

This study confirms that food insecurity is a major problem in Sub-Saharan Africa. The lowest prevalence of food energy deficiency found at the country level is 37 percent, for Uganda. Even in this country more than one-third of all people do not have access to sufficient food to meet their energy requirements for light activity. The prevalence varies widely across the study countries, rising to as high as 76 percent in Ethiopia. The following is the ranking of the countries on the prevalence of food energy deficiency, from highest to lowest:

- Ethiopia (76.4 percent)
- Burundi (74.8 percent)
- Malawi (73.3 percent)
- Zambia (71.1 percent)
- Rwanda (65.3 percent)
- Mozambique (60.3 percent)
- Senegal (60.2 percent)
- Ghana (51.4 percent)
- Guinea (45.1 percent)
- Tanzania (43.9 percent)
- Kenya (43.9 percent)
- Uganda (36.8 percent)

Seven of the countries—Burundi, Ethiopia, Malawi, Mozambique, Rwanda, Senegal, and Zambia—are found to have severe problems with food insecurity that are compounded by insufficient national food availabilities. In these countries, the average energy availability per capita falls below the average person's energy requirement for light activity, indicating that there is not enough food for all people even if it were to be distributed according to need. Nearly all of them had experienced adverse climatic shocks or conflict-induced instability in the years leading up to their surveys. In the remaining countries, enough food was available to meet the energy needs for light activity of all in the survey years; thus, income inequalities and poverty were likely the primary forces driving food insecurity. In Sub-Saharan Africa, policies to reduce food insecurity must continue to focus on both food availabilities and food access. Conflict- and climate-induced transitory food insecurity as well as poverty-induced chronic food insecurity must both be addressed.

Although international guidelines for diet diversity are yet to be established, the measure used in this study indicates that problems of diet quality are widespread in most of the countries. Low diet diversity appears to be a relatively minor problem in the three West African countries. Prevalences in the East and southern African countries are much higher, with the highest found in Mozambique. Notably, there is not a strong association between the diet quantity and quality measures, suggesting that these two aspects of food insecurity have quite different distributions across households and, possibly, differing determinants. If both aspects are taken into account, country rankings are substantially different from what they are when only diet quantity is considered, which is the convention. These findings suggest that it is imperative that diet quality be addressed as an integral part of strategies for achieving food security and that measures of it be included in food security assessment.

HESs offer a rich lens through which to examine food insecurity within countries as well. The socioeconomic characteristics examined here—region of residence, urban or rural residence, income group, and female- or male-headed household—are only a few among many others that can be used, depending on the data collected in each survey. Further, when combined with census data, HESs can be used to create finer hunger maps than can be created with HES data alone, for which sample sizes limit estimates to broad administrative regions.

The patterns found here illustrate the usefulness of the surveys for understanding where food insecurity is as well as which population groups are most vulnerable. Although some of the study countries display a pattern of commonality in the severity of food insecurity across regions, others, as illustrated by Tanzania, show great variation in both diet quantity and quality measures. We are reminded, once again, that national estimates of food insecurity often mask wide variability within countries that must be taken into account by policymakers in allocating scarce resources.

This study finds food energy deficiency prevalences to be lower in urban than rural areas for some countries, although the opposite holds for others. In seven of the study countries, the urban rate of food energy deficiency is close to or higher than the rural rate. This may be because urbanization is increasing in Sub-Saharan Africa and because food insecurity is moving to the cities. When it comes to diet quality, urbanites are found to have a clear advantage, partly because of better access to markets. Female-headed households are not consistently found to be doing worse than male-headed households when it comes to diet quantity. However, in the regions where diet quality is a major problem, East and southern Africa, the general finding is that they are doing worse in the area of diet quality, suggesting that they are a vulnerable group when it comes to this aspect of food security. As expected, income has a very strong bearing on food security. For both diet quantity and quality measures, the prevalence of food insecurity generally falls quickly as one moves from the poorest 20 percent of countries' populations to the richest.

Scientific Merit of Household Expenditure Surveys for Measuring Food Insecurity

The indicators of diet quantity and quality that can be measured using the data in HESs are conceptually valid indicators of food security. Although they fail to capture all aspects of its definition (including vulnerability, food safety, and food preferences), they do encompass two of the most foundational components: access to sufficient food and the nutritional quality of the food consumed.

The data collected in HESs have a reliable information foundation. They are based on the words of people who consume the food. In this sense, it is a "bottom up" approach to measurement in contrast to the FAO and USDA approaches, which rely on summary information at the country level as their starting points. Further, people generally have little incentive to misrepresent a short period of time. Finally, the analysis of Chapter 6 suggests no major problems of memory failure over the recall periods for which data are collected (typically 1 day to 2 weeks). Although some reliability issues remain to be investigated (see below), the estimates based on HESs are thus likely to be reasonably accurate.

The data cleaning, processing, and computation protocols employed for this research are standard for all countries. However, the country surveys differ widely in data collection methodologies, including the recall and reference periods used, the number of foods for which data are collected, whether the data are collected using the interview or diary method, and whether data are collected for in-kind foods. Evidence is presented here that food insecurity measures calculated using HES data are nevertheless largely comparable across countries.

Differences in Household Expenditure Survey and FAO Estimates

FAO estimates of food energy deficiency are being used to monitor Millennium Development Goal number 1, to eradicate extreme poverty and hunger. They are also used by numerous international development agencies to help target countries that are most food insecure. FAO's estimates and those reported here based on HES data are calculations of the same measure: the prevalence of food energy deficiency. One would thus expect them to have a strong association with one another. However this study finds little correspondence between them, with their correlation coefficient being 0.46 and not statistically significant. The two methods yield quite different pictures of the magnitude of food insecurity for the study countries as well as their relative rankings.

The main source of the discrepancy between HES and FAO estimates is found to lie in differences in the national-level parameters used for generating the FAO estimates rather than in the underlying log-normal probability distribution model employed. These parameters are (1) mean dietary energy requirement of the population; (2) mean energy availability; and (3) coefficient of variation in energy consumption (for the FAO methods) or availability (for the HES method), which describes the distribution of the food energy available across a country's population.

With respect to energy requirements, FAO employs a "minimum" requirement for light activity (around 1,800 kilocalories) with the intention of identifying people having an unacceptably high risk of food energy deficiency. When this requirement is used, although all people identified as deficient are indeed likely to be food insecure, many more who are food insecure are missed. This study employs instead the "average" requirement for light activity (roughly 2,050 kilocalories), as recommended by the 1985 FAO/UNU/WHO

Expert Consultation on Energy and Protein Requirements. The intention is to identify people who consume insufficient dietary energy to meet their needs. When this requirement is used, there will also be some classification error, of both the food secure and food insecure, errors that are hoped to cancel each other out in the final estimation of a country's prevalence of food energy deficiency. The difference in the energy requirements assumed explains why FAO estimates of food energy deficiency are almost uniformly lower than those reported here.

With respect to dietary energy availability, for all of the countries except one, there are strong differences between those estimated using FAO food balance sheets and those using HES data, over 150 kilocalories per capita per day and rising to as high as 600. There is no consistent pattern in the direction of the difference. As for the distribution of the available food energy, the coefficients of variation generated from HESs are found to be much higher than those used by FAO, double on average.

When FAO estimates of food energy deficiency are recalculated using the HES-derived parameters, the differences between the two estimates are reduced, and their correlation is higher. When the same energy requirements are used, the average difference in the food energy deficiency estimates drops substantially. However, the correlation rises only from 0.46 to 0.56, suggesting that although use of the same requirements would improve the comparability of estimates, it is not the only reason for the large disparities found. The correlation rises to 0.60 when the same coefficients of variation are employed. It rises the most when the dietary energy availabilities are equalized, to 0.98 or almost 100 percent agreement. These results imply that the most important factor underlying the divergence in HES and FAO estimates of food energy deficiency for Sub-Saharan African countries is differences in underlying estimates of national food energy availability.

How Household Expenditure Surveys Can Contribute to a More Reliable Global Food Security Database

HES estimates of food energy deficiency are found to be more strongly associated with other MDG indicators of poverty and hunger than are FAO estimates. The correlation between HES country rankings of food energy deficiency and poverty is 3.6 times higher than that for the FAO estimates. The same correlation for child malnutrition is 1.7 times higher. Thus, HES estimates are more closely associated with conceptually similar indicators that are believed to be reliably measured. They are also somewhat more consistent with country rankings based on a survey of expert opinion. These findings provide empirical support that HES data would be a useful source of information for improving the accuracy of FAO estimates of food insecurity.

The main advantages of using HES data for measuring food insecurity are that (1) they are a source of multiple, policy-relevant, valid, and reasonably reliable measures; and (2) they allow multilevel monitoring and evaluation, including that of within-country and national food insecurity and, given data from a sufficient number of countries, of regional and developing-world-wide food insecurity as well. Their main disadvantage is that data are not collected for all countries regularly, partly because of the financial resources and skill levels required for data collection, processing, and analysis. Creating a database of cross-country comparable estimates of food insecurity based soundly on household-level data, although currently not feasible, is fast becoming a reality as the surge in the collection of HESs that began in the 1990s continues.

Meanwhile, HES data can be used to improve the accuracy of FAO's estimates, which are currently reported for almost all developing countries on an annual basis, in a number of ways. First, as suggested by

Logan Naiken (in Smith 1998b), then Chief of FAO's Statistical Analysis Service, they can be used to improve estimates of countries' food supplies available for human consumption. This would be most valuable for foods whose production and trade are hard to measure, such as roots and tubers, and for home-produced foods, which are usually not captured in the production statistics entering into food balance sheet calculations. The first step in this undertaking would be to compare food balance sheet and HES-derived estimates of the quantities available of individual foods to determine where the main discrepancies lie. It is important to note that the data in FAO's food balance sheets are an integral component of the current food security information system in their own right and have many valuable uses beyond measuring food energy deficiency. For example, the energy availability data are essential for conducting studies of the determinants and best predictors of food insecurity.

Second, HES data can be used to improve the accuracy of available estimates of the distribution of dietary energy across countries' populations and improve their availability. Finally, the estimates of food energy deficiency derived from HESs can continue to serve as a reference for comparison and validation.

The Need for Additional Research

To undertake the above endeavors requires, first and foremost, that the analysis of this report be extended to the other developing regions. This will increase the number of country-level estimates of food insecurity that are the essential data for (1) improving estimates of food energy availabilities and of the distribution of food energy across countries' populations; and (2) generating regional and developing-world estimates of prevalences of food insecurity and examining how they change over time using the FAO or alternative methods.[46] Such estimates are particularly urgent for Sub-Saharan Africa and South Asia, the regions believed to have the deepest food insecurity problems but for which currently existing international statistics give widely contrasting pictures (Smith et al. 1999). Analysis is currently under way for Asia. The effort needs to be expanded to Latin America and the Caribbean, to the Near East, and to North Africa.

Second, research on the appropriate requirement to use in identifying the food energy deficient needs to be conducted. In particular, it would be valuable to determine which of the energy requirements for light activity, minimum or average, gives the smaller error.

Third, some basic research on the reliability issues identified in this report pertaining to the estimation of food energy deficiency using HES data needs to be undertaken. These are (1) error in the estimation of energy acquired from food eaten away from home and how it can be reduced; (2) the influence on food energy deficiency prevalences of the use of food acquisition rather than food consumption data; (3) the magnitude of bias in estimates of food energy deficiency resulting from nonsampling errors and short reference periods for food data collection; (4) the magnitude of food quantities acquired that are wasted and given to pets and guests; (5) the accuracy costs of disregarding the intrahousehold distribution of food; and (6) how well the "low diet diversity" measure used here identifies households and people who fail to consume adequate amounts of all essential nutrients.

Finally, as seen in this study, many HESs are not undertaken with the intention of

[46]Alternative approaches for doing so, including that employed by the World Bank for estimating poverty prevalences, are presented in Appendix E.

calculating measures of food insecurity in mind. Because of this, they may not contain a large enough number of sufficiently detailed food categories, or complementary data may not be collected for converting the expenditures or quantity data to metric quantities. To remedy these problems, and thereby increase the number of data sets that can be used to generate the information needed for sound food security policy decisionmaking, a set of guidelines containing the best practices for collecting and processing the food data in HESs is needed.

APPENDIX A

Data Sets Not Included in the Study and Reasons Why

Table A.1 Data sets not included in the study and reasons why

		Reason(s) dropped					
Country	Year	Fewer than 30 food items	Recall period greater than one month	No data on home-produced food	No data for converting to metric quantities	More recent survey available	Other
Burkina Faso	1998				x		
Burkina Faso	1994	x					
Burundi	1998						
Cameroon	2001			x			
Cameroon	1996	x		x			
Central African Republic	1995						x
Central African Republic	1992	x					
Comoros	1995				x		
Cote d’Ivoire	1998	x	x		x		
Cote d’Ivoire	1995	x	x		x		
Cote d’Ivoire	1992	x	x				
Djibouti	1996	x		x			
Ethiopia	2000						
Ethiopia	1998	x	x	x	x		
Ethiopia	1997	x					
Ethiopia	1995					x	
Gambia	1998				x		
Gambia	1994	x					
Gambia	1993	x					
Gambia (Priority survey)	1992	x	x				
Gambia (Integrated survey)	1992				x		
Ghana	1998						
Ghana	1991		x			x	
Guinea	1994						
Guinea	1991	x		x			
Guinea-Bissau	1993				x		
Guinea-Bissau	1991						x
Kenya	1997						
Kenya	1994					x	
Kenya	1992	x	x			x	
Lesotho	1995						x
Lesotho	1993					x	

(continued)

Table A.1—Continued

Country	Year	Reason(s) dropped					
		Fewer than 30 food items	Recall period greater than one month	No data on home-produced food	No data for converting to metric quantities	More recent survey available	Other
Madagascar	1999		x				
Madagascar	1997		x				
Madagascar	1993		x				x
Malawi	1997						
Malawi	1990	x				x	
Mali	1994	x		x			
Mauritania	2000						x
Mauritania	1995				x		
Mauritania	1993	x					
Mauritania	1992	x					
Mozambique	1996						
Namibia	1993						x
Niger	1995	x	x				
Niger	1994	x					
Nigeria	1996						x
Nigeria	1993						x
Nigeria	1992						x
Rwanda	1998						
Rwanda	1993					x	
Sao Tome & Principe	2000	x					
Senegal	2001						
Senegal	1994	x	x				
Seychelles	1991						x
Sierra Leone	1994						x
South Africa	1995		x				
South Africa	1993	x					
Swaziland	1995						x
Tanzania	2000						
Tanzania	1993		x				x
Uganda	1999						
Uganda	1996					x	
Uganda	1995					x	
Uganda	1994					x	
Uganda	1993					x	
Uganda	1992		x			x	
Zambia	1998				x		
Zambia	1996						
Zambia (Expenditure survey)	1993					x	
Zambia (Priority survey)	1993	x	x				
Zambia (Expenditure survey)	1991	x	x			x	
Zambia (Priority survey)	1991	x	x				
Zimbabwe	1995						x
Zimbabwe	1993						x
Zimbabwe	1990						x

Notes: Shaded countries are those included in the study. Further information on the "other" reasons that data sets were not included can be obtained from the authors.

APPENDIX B

Data Collection and Processing by Country

Burundi 1998

Survey Name and Dates
Enquête Prioritaire 1998 (Etude nationale sur les conditions de vie des populations) October 1998 to March 1999

Data Collection Agency
Institut de Statistiques et d'Etudes Economiques du Burundi (ISTEEBU)

Sample Design and Size
A two-stage stratified sampling design was used.

The strata are the following five geographical areas: Bujumbura-Mairie, Zones des plaines, Montagnes et zones de transition, Plateaux Occidentaux, and Plateaux Orientaux.

In rural areas and noncapital urban areas, the first-stage primary sampling units (PSUs) are "sous-collines" (SCs). In the capital city, the PSUs are census enumeration areas (EAs).

The second stage unit is households, with 10 selected in each of 452 SCs and 20 selected in each of 134 EAs.

The sample size was originally to be 7,200 households (10 × 452 SCs + 20 × 134 EAs), but because of difficulties gaining access to certain areas, it was reduced to 6,668.

Food Data Collection
Households reported their expenditures on food purchases (for 34 foods) and quantities in local units of home-produced foods consumed (for 33 foods) over the 15 days preceding the enumerator's single visit. The recall and reference periods for food data collection were both 15 days. Although households were asked if they had received gifts of food, they were not asked to give an estimated value or quantity. Thus, this data set does not include food received as a gift in its calculations of food quantities and calories acquired.

Calculation of Metric Food Quantities
For food purchases, monthly metric prices for 16 provinces provided by the ISTEEBU were used to convert reported expenditures into metric quantities.

For home-produced food, local-to-metric unit conversion factors provided by the ISTEEBU were used to convert reported quantities of food acquired in local units into metric quantities.

Sources of Calorie Conversion Factors
The primary source is the food composition table for use in Africa (Leung 1968). Secondary sources are *The composition of foods commonly eaten in East Africa* (West, Pepping, and

Temalilwa 1988) and the *USDA nutrient database for standard reference,* release 15 (USDA 2002).

Data Cleaning and Processing

The metric prices were cleaned by comparison of prices for each food across provinces and months. The local unit conversion factors were cleaned by food and unit code, taking into account consistency in the relative weights of foods measured in the same-sized containers.

The number of households dropped was 83, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (20 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (59 households).
- All household members were declared to be "absent" (four households).

The number of households for which calorie availability was estimated is 66, for the following reasons:

- The calorie content of food prepared away from home could not be estimated (31 households).
- No food acquisitions were recorded for the household (35 households).

The number of households included in the analysis is 6,585.

People Consulted

- Mr. Vedaste, Director, ISTEEBU.
- Mr. Emmanuel Nindagiye, Director of Data Processing, ISTEEBU

Documents Consulted

ISTEEBU. 2001. Enquête Prioritaire 1998: Etude nationale sur les conditions de vie des populations (Survey report). Burundi: Institut de Statistiques et d'Etudes Economiques du Burundi.

Ethiopia 1999

Survey Name and Dates

Household income, consumption, and expenditure survey 1999/2000, June 1999 to February 2000.

Note that the survey took place in two rounds covering the two major seasons: the slack season and the peak (harvest) season. The first round of data collection took place June–August 1999; the second took place January–February 2000.

Data Collection Agency

Central Statistical Authority of Ethiopia (CSA).

Sample Design and Size

The survey covered the population in sedentary areas of the country, excluding the nonsedentary populations in Afar and Somali Regional States.

In rural and metro urban areas (11 regional capitals and major urban centers), a two-stage stratified sampling design was used. The strata in rural areas are 11 *killils,* or regions. The strata in metro urban areas are 15 regional capitals and urban centers. The first-stage primary sampling units (PSUs) are census enumeration areas (EAs). The second-stage unit is households, with 12 selected in each rural EA and 16 in each metro urban EA.

In nonmetro urban areas, a three-stage stratified sampling design was used. The strata are the 9 *killils* containing any nonmetro urban center. The PSUs are nonmetro urban centers. The second stage units are EAs. The third-stage unit is households, with 16 selected from each EA.

The total number of households planned for the sample was 17,336. Four households refused to cooperate, giving a final sample size of 17,332 households.

Food Data Collection

In each of the two rounds, households were asked to report on their acquisition of 230 foods from purchases, own production, and in-kind receipts through twice-weekly interviews over a 4-week reference period (that is, eight times over 4 weeks). The recall period for food data collection was 3–4 days. Households were asked to report the quantity of foods acquired, the unit of measure reported in, and the monetary value of each food acquired.

Calculation of Metric Food Quantities

In most cases, foods acquired were weighed by the enumerators at the household level. Thus, the large majority of the food quantities recorded (97.5 percent) were already given in metric units in the final data set released. Among the remaining cases, 0.6 percent were recorded in unities. The only food falling into this category is eggs, for which the metric weight of 1 medium egg from USDA's Nutrient Database Release SR15 (USDA 2003) was employed. Finally, the rest of the cases were converted to metric quantities using reported expenditures divided by metric unit values. The source of the metric unit values is area medians of household-level unit values, where the areas, in preferred order, are cluster, zone (an administrative division below the *killil* level), *killil,* and national.

Sources of Calorie Conversion Factors

Most of the conversion factors used were provided by the CSA with the data set. The sources of these factors are

1. Composition of foods (USDA 1963)
2. Food composition table for use in Ethiopia (Agren and Gibson 1968)
3. Expanded food composition table for use in Ethiopia (ENI 1968)
4. Food composition table for use in Africa (Leung 1968)
5. Food composition tables for use in Middle East (Pellet and Shadarevian 1970)

Where the conversion factors provided differed substantially from those of other African sources and USDA (2003), alternative sources were used as follows:

1. The composition of foods commonly eaten in East Africa (West, Pepping, and Temalilwa 1988)
2. National food composition tables and the planning of satisfactory diets in Kenya (Sehmi 1993)
3. Food composition table for use in Africa (Leung 1968)
4. USDA nutrient database for standard reference, release 15 (USDA 2002)

Data Cleaning and Processing

Household-level unit values (reported expenditure divided by metric quantity) were manually examined for each food and unit of measure for outliers.

The number of households dropped was 26, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (25 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (1 household).

The number of households for which calorie availability was estimated is 21, for the following reasons:

- Metric quantity could not be calculated for at least one food acquired (12 households).
- The calorie content of food prepared away from home could not be estimated (9 households).

The number of households included in the analysis is 17,306.

People Consulted

- Mr. Zekaria, Deputy General Manager, CSA

Documents Consulted

Central Statistical Authority of Ethiopia. 2001. *Report on the 1999/2000 household income consumption and expenditure survey.* Addis Ababa: Statistical

Bulletin. Central Statistical Authority. The Federal Democratic Republic of Ethiopia.

Central Statistical Authority of Ethiopia. 1999. *Integrated household survey program. Household income, consumption and expenditure survey, 1991 E.C. Code book for urban sample EAs.* Addis Ababa: The Federal Democratic Republic of Ethiopia.

Special Note on Estimate of Per Capita Calorie Availability

Central Statistical Authority of Ethiopia (2001) above reports a mean per capita household calorie availability of 2,211.2 kilocalories. That estimated in this report is substantially lower, at 1,648 kilocalories. Some of the difference can be explained by the cleaning procedures employed in the report (see Chapter 3). As part of these procedures, any estimated per-adult-equivalent metric quantity of a food that lies more than three standard deviations from the sample median is considered an erroneous outlier and replaced with an estimated value based on each households' characteristics (using multiple regression techniques). For Ethiopia, this procedure reduces the per capita calorie availability by 250 kilocalories. On examination, the outlying values that are replaced are extraordinarily high. For example, for the staple crop most widely acquired by sample households, maize, any adult equivalent quantity greater than 725 grams per day was considered an outlier. The (unweighted) median value is 85.6 grams, by contrast. Of the outliers, one-third are cases of consumption of own production, suggesting the possibility that some households may have reported quantities harvested rather than quantities consumed over the survey reference period.

There are two other possible sources of the difference between the mean per capita calorie availabilities reported by CSA and that given in this report. The first is that the CSA value may be based on household-level mean calorie availability rather than individual availability, which would lower per capita calorie availability by approximately 85 kilocalories. The second is that the CSA value may be based on calorie values unadjusted for edible portions of foods, which would lower per capita calorie availability by approximately 145 kilocalories. Indeed, when the per capita calorie availability difference is evaluated by food group, we find that the biggest differences are for roots and tubers, fruits, and vegetables, for which edible portions are generally less than 100 percent.

Ghana 1998

Survey Name and Dates

Ghana Living Standards Survey 4 (GLSS4), April 1998 to March 1999.

Data Collection Agency

Ghana Statistical Service (GSS)

Sample Design and Size

A two-stage stratified sampling design was used. The six strata are urban and rural areas within three ecological zones (coastal, forest, and savannah). The first-stage primary sampling units (PSUs) are 300 Enumeration Areas (EAs). The second-stage units are households, with 20 selected from each EA.

The total sample size was 6,000 households.

Food Data Collection

Households reported their expenditures on food purchases (for 103 foods) and quantities in local units of home-produced foods consumed (57 foods) over six visits with 5-day reference periods for each. Additionally, data were collected on the prices of foods in local units.[47] The reference period

[47] Households were asked: "For how much could you sell one unit of (food name) now?"

for food data collection was 30 days. To facilitate recall, a diary of daily consumption and expenditures was used. If a literate household member was available, this person maintained the diary and then submitted it to the enumerator at the next visit to enter into the main questionnaire. If not, then the enumerator visited the household on a daily basis to maintain the diary. The recall period was thus 1 day. On one of the visits, households were also asked to report the total value of the gifts in food they had received over the last year.

Calculation of Metric Food Quantities

For food purchases, reported expenditures were divided by metric prices. The sources of the price data and the percentage of household-food cases converted to metric quantities for each are:

- A market price survey conducted in conjunction with GLSS4, where the markets correspond to the EAs in which the households reside (48.9 percent)
- Monthly prices collected in each region by the GSS as part of data collection for Ghana's Consumer Price Index (35.5 percent)
- Prices estimated from those of similar foods with the original source being one of the above (14.7 percent)

For home-produced food, quantities of food reported in local units were converted to metric units using either:

- Metric weights of foods in local units of measure collected as part of previous International Food Policy Research Institute surveys as well as some collected in 2002 by IFPRI Research Analyst Ellen Payongayong (27.5 percent)
- Metric weights estimated using a ratio of local unit prices reported by individual households to metric prices (from the sources listed in the purchases section above) (72.5 percent)

The first method was preferred for foods reported in units of measure with standard sizes. The second was preferred for those with widely varying sizes, for example, baskets and tins.

For gifts, price per calorie estimates from foods prepared inside the home were applied to total gift expenditures.

Sources of Calorie Conversion Factors

The primary source is:

- Composition of foods commonly used in Ghana (Eyeson and Ankrah 1975)

Secondary sources are:

- Food composition table for use in Africa (Leung 1968)
- Nutrient composition of commonly eaten foods in Nigeria—raw, processed, and prepared (Oguntona and Akinyele 1995)
- USDA nutrient database for standard reference, release 15 (USDA 2002)

Data Cleaning and Processing

The market survey and CPI prices were cleaned thoroughly through examination of all prices available for each food. The metric weights of food in local units of measure were cleaned by food and unit code, taking into account whether the relative weights of foods measured in the same containers made sense.

The number of households dropped was 60, for the following reasons:

- Dropped by GSS before release of the data set (2 households)
- The estimated calorie availability per adult equivalent was greater than 12,000 kilocalories (58 households).

The number of households for which calorie availability was estimated is 642, for the following reasons:

- Metric quantity could not be calculated for at least one food acquired (538 households).

- The calorie content of food prepared away from home could not be estimated (4 households).

The number of households included in the analysis is 5,940.

People Consulted

Various staff members of the GSS, the Policy Planning, Monitoring, and Evaluation Department (PPMED), and the department responsible for Consumer Price Index calculations.

Documents Consulted

Asenso-Okyere, W. K., K. A. Twum-Baah, A. Kasanga, J. Anum, and C. Portner. 2000. *Ghana living standards survey: Report of the fourth round (GLSS4).* Accra: Ghana Statistical Service.

Coulombe, H., and A. McKay. 2000. *The estimation of components of household incomes and expenditures: A methodology guide based on the Ghana living standards survey, 1991/1992 and 1998/1999.* Accra: Ghana Statistical Service.

Ghana Statistical Service. 2000. *Poverty trends in Ghana in the 1990s.* Accra: Ghana Statistical Service.

Guinea 1994

Survey Name and Dates

Enquête intégrale sur les conditions de vie des ménages guinéens avec module budget et consommation January 1994–February 1995.

Data Collection Agency

Direction Nationale de la Statistique de la République de Guinée (DNS), Ministère de Plan et de la Coopération.

Sample Design and Size

A two-stage stratified sampling design was used.

The nine strata are the four "natural regions" (Basse Guinee, Moyenne Guinee, Haute Guinee, and Guinea Forestiere) in addition to the capital, Conakry, divided into urban and rural areas.

In rural areas, the first-stage primary sampling units (PSUs) are a subsample of 84 clusters drawn from those selected for a previous national survey, the "Enquete sur les Informations Prioritaires" of 1991. The second-stage unit is households, with 20 selected from each cluster.

In urban areas, the first-stage PSUs are 228 clusters drawn from the same previous survey. The second-stage unit is households, with 12 households selected from each cluster.

The total sample size was 4,416.

Food Data Collection

Households reported their expenditures on food purchases (for 116 foods) and quantities in local units of home-produced foods consumed (for 82 foods). For home-produced foods, the price of 1 unit of the food was also reported. In rural areas, enumerators visited households at 2-day intervals over seven visits. The recall period for food data collection was thus 2 days, and the reference period 14 days. In urban areas, households were visited at 3-day intervals over 10 visits, giving a recall period of 3 days and a reference period of 30 days.

Calculation of Metric Food Quantities

For food purchases, reported expenditures were divided by metric prices from the following sources:

- A market price survey conducted in conjunction with the household survey, where the markets correspond to the EAs in which the households reside (94.0 percent)
- Reported by households in the home-produced foods questionnaire (1.0 percent)
- Imputed from 2002 CPI prices collected by the DNS in Conakry and collected by Dede Aduayom in a Conakry market (4.9 percent) (note: 1994 CPI prices were not available)

For home-produced food, local quantities were converted to metric quantities using local unit conversion factors from the following sources:

- Provided by the DNS (15 percent of cases)
- Derived from factors reported by the USDA or from African countries (8.5 percent)
- Sample-level estimated local unit conversion factors (LUCFs) for standard-sized containers (3.1 percent)[48]
- Household-level estimated LUCFs for nonstandard-sized containers (66.5 percent)[49]

Note that 6.8 percent of the cases were reported directly in metric quantities and thus did not need conversion.

Sources of Calorie Conversion Factors

The primary source is:

- *The Composition of Malian Foods* (Nordeide 2003)

Secondary sources are:

- *USDA nutrient database for standard reference,* release 15 (USDA 2002)
- *Food composition table for use in Africa* (Leung 1968)
- *The composition of foods commonly eaten in East Africa* (West, Pepping, and Temalilwa 1988)
- *Composition of foods commonly used in Ghana* (Eyeson and Ankrah 1975)

Data Cleaning and Processing

The prices from the community price survey were cleaned thoroughly through examination of all prices available for each food.

The number of households dropped was 44, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (8 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (36 households).

The number of households for which calorie availability was estimated is 36, for the following reasons:

- The calorie content of food prepared away from home could not be estimated.
- No food acquisitions were recorded for the household.

The number of households included in the analysis is 4,372.

People Consulted

- Mr. Oumar Diallo, Director, DNS
- Mr. Morot, SETYM International, Montreal, Canada

Documents Consulted

Direction National de la Statistique de la République de Guinée. 1998. *Guide d'utilisation des données de l'enquête intégrale avec module budget-consommation 1994–1995.* Conakry: Ministère du Plan et de la Coopération, Direction National de la Statistique, Republique de Guinée.

Ministère du Plan et de la Coopération de la République de Guinée. Undated. *Un profil de pauvreté en Guinée. Enquête intégrale sur les conditions de vie des ménages guinéens avec module budget et consommation.* Conakry: Projet d'Appui au Développement Socio-Economique Enquête permanenete (PADSE) auprès de ménages.

Diallo, O. Undated. *Enquête intégrale sur les conditions de vie des ménages guinéens avec module budget et consommation :*

[48]These were derived by dividing sample-level prices reported by households of foods in the containers by metric prices from the community price survey.

[49]These were derived by dividing household-level reported prices of foods in the containers by metric prices from the community price survey.

Agregation des dépenses et revenues. Conakry: Projet d'Appui au Développement Socio-Economique. Enquête permanenete auprès de ménages.

SETYM. 1996. Estimations des apports énérgetiques et nutritionnels de la consummation alimentaire: République de Guinée. Rapport de mission. Montreal: SETYM International, Inc.

Kenya 1997

Survey Name and Dates

Welfare Monitoring Survey III, April–June 1997.

Data Collection Agency

Central Bureau of Statistics (CBS), Ministry of Planning and National Development.

Sample Design and Size

Two-stage (for urban areas) and three-stage (for rural areas) stratified sampling designs were used. The strata are 46 districts[50] within the country.

In rural areas, the first-stage primary sampling units (PSUs) are census enumeration areas (EAs). The second-stage unit is clusters selected from within the EAs. The third-stage unit is households, with, on average, 12 selected in each cluster.

In urban areas, the PSUs are clusters. The second-stage unit is households, with, on average, nine selected in each cluster.

The total sample size was 10,874.

Food Data Collection

Households were asked about their purchases and consumption of home produce of 70 foods in a one-time interview, reporting on the number of units acquired, the unit of measure reporting in, and the price of one unit of measure of the food from both sources.

The reference and recall periods for food data collection were 7 days. In many cases, the enumerators recorded metric weights of one unit of measure of the foods reported either by asking the respondent directly (for example, bottle size for beverages) or by weighing the food using a mobile scale. This data set does not include food received as a gift in its calculations of food quantities and calories acquired.

Calculation of Metric Food Quantities

A combination of methods, with the same approach applied to both food purchases and food acquired through home production, was employed.

Method 1. When metric quantities (kilograms or liters) were reported directly by households or recorded by the enumerators given standard-size containers (for example, bottles of soft drinks), these quantities were directly employed (41 percent of the cases).

Method 2. When the weights of foods in reported local units of measure (collected by enumerators using mobile scales) were deemed to be reliable, these were multiplied by the reported local quantities (16.7 percent of the cases). Note that USDA weights were used for cases where eggs, pineapples, oranges, mangos, and avocados were reported in unities.

Method 3. Where only the quantity in local units and price were available, these values were multiplied together to arrive at total expenditure on the food and subsequently divided by metric prices (42.1 percent). To derive metric prices, medians of the metric prices associated with the quantities used in Method 1 above were calculated at various levels of aggregation if at least five prices were available at that level. Cluster-level

[50]All districts within the countries' eight provinces (and a few clusters in some districts) could not be covered because of resource limitations and lack of adequate security.

prices were used in 6 percent of the conversions, district-level prices in 73.1 percent, province-level prices in 15.4 percent, and national-level prices in 5.5 percent.

Sources of Calorie Conversion Factors

The primary source is

- *National food composition tables and the planning of satisfactory diets in Kenya* (Sehmi 1993)

Secondary sources are:

- *Food composition table for use in Africa* (Leung 1968)
- *The composition of foods commonly eaten in East Africa* (West, Pepping, and Temalilwa 1988)
- *USDA nutrient database for standard reference,* release 15 (USDA 2002)

Data Cleaning and Processing

The raw data received from the CBS required line-by-line cleaning because of a number of enumerator recording issues. These included cases where:

- The recorded prices were total expenditure rather than price per unit.
- Recorded weights for local units of measure were weights of the entire acquisition rather than unit weights.
- The units of measure were incorrect (for example, grams instead of kilograms, kilograms instead of liters).

In many cases the recorded values could be corrected by comparing across the values for other variables. Another source of information relied on in the cleaning process was Consumer Price Index metric prices for 1997 provided by the CBS. Where the correct value was not obvious, all values were set to missing, and the metric quantity was estimated following the standard protocol.

The number of households dropped was 275, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (73 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (202 households).

The number of households for which calorie availability was estimated is 45, for the following reason:

- The calorie content of food prepared away from home could not be estimated (45 households).

The number of households included in the analysis is 10,599.

People Consulted

- David S.O. Nalo, Director of Statistics, CBS
- Samuel Kip, Statistician, CBS

Documents Consulted

Second report on poverty in Kenya, Volume I: Incidence and depth of poverty. Central Bureau of Statistics, 1997.

Malawi 1997

Survey Name and Dates

Integrated Household Survey 1997/98 November 1997–October 1998

Data Collection Agency

National Statistical Office (NSO), Government of Malawi.

Sample Design and Size

Two- and three-stage stratified sampling designs were used.

The strata are the country's 25 administrative districts plus 4 major urban centers.

In urban areas, two-stage sampling was used. The first-stage primary sampling units (PSUs) are census enumeration areas (EAs). The second-stage units are households, with 10 selected in each EA.

In rural areas, three-stage sampling was used. The PSUs are "traditional authorities" (TAs). The second-stage units are EAs. The third-stage units are households, with 20 selected in each EA.

The total sample size is 12,960 households. Some households were dropped in an initial cleaning by the NSO, leaving 10,698 households in the final data set released.

Food Data Collection

For food purchases, households maintained a diary for a minimum of 14 days and a maximum of 28 days (the survey has a variable reference period for food data collection). They were asked to record the quantity, unit of measure, and expenditure on each food item purchased every day. One diary was given to each household member above 10 years old who could maintain the diary him- or herself, and the enumerator maintained a diary for the remaining members above 10 years. If the diary was kept by the enumerator, the recall period was a maximum of 3 days. If kept by a household member, the recall period was 1 day.

For foods obtained from own production, barter, gifts, and other noncash sources, enumerators visited each household once, recording the quantity acquired over the previous 3 days, unit of measure, and estimated value. For these food sources, the recall and reference periods were both 3 days.

The total number of food items for which data were collected is 274.

Calculation of Metric Food Quantities

For food purchases, although quantities and units of measure were collected from households in the daily diary, these were not employed because of recording problems. The method used for all observations was reported expenditures divided by metric prices.

The prices were collected by the Consumer Price Index office at the National Statistical Office. They are available on a monthly basis for the four urban centers and three rural regions.

For home-produced and in-kind food acquisitions: 26.2 percent of the cases were already recorded in metric quantities, 61.7 percent of the cases were converted using local unit conversion factors, and 12.1 percent of the cases were converted using reported expenditures divided by metric prices. The source of the local unit conversion factors is metric weights collected in the Zomba area of Malawi.

Sources of Calorie Conversion Factors

- *Useful plants of Malawi* (Williamson 1975)
- *Food composition table for energy and eight important nutrients in foods commonly eaten in East Africa* (West et al. 1987)
- *USDA nutrient database for standard reference,* release 13 (USDA 1999)
- Nutritional table manual published by the Technical Centre for Agriculture and Rural Cooperation (CTA) of ACP/ECP Convention of Lome, and Food and Nutrition Cooperation (ECSA) Department of Human Nutrition, Wageningen Agricultural University (no additional bibliographic information)

Data Cleaning and Processing

In documentation released with the dataset, survey analysts identified 1,577 of the 10,698 households as having unreliable expenditures data (see Government of Malawi documents below). Calorie availability was predicted for most of these households, and others were dropped.

The number of households dropped was 176, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (21 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (14 households).
- Household was identified as having unreliable expenditures data and, in addition, had no recorded expenditures over the reference period (141 households).

The number of households for which calorie availability was estimated is 1,605, for the following reasons:

- Metric quantity could not be calculated for at least one food acquired (28 households).
- Food expenditure data were considered unreliable by survey analysts (1,436 households).

The number of households included in the analysis is 10,522.

People Consulted

- Todd Benson, International Food Policy Research Institute
- Ellen Payongayong, International Food Policy Research Institute

Documents Consulted

National Statistical Office, Government of Malawi. 1997. *Integrated household survey November 1997–October 1998: Interviewer's manual.* Zomba, Malawi: National Statistical Office.

Integrated Household Survey, 1997–1998. *Data file dictionary.*

Government of Malawi. 2000. *Criteria used for selecting sample households for the poverty analysis of the Malawi Integrated Household Survey, 1997–98.* Working Paper No. 1. *Poverty analysis of the Malawi Integrated Household Survey 1997–98.* Zomba, Malawi: Poverty Monitoring System, Government of Malawi.

Government of Malawi. 2000. *Assessing poor or non-poor bias in the criteria used for selecting sample households for the poverty analysis of the Malawi Integrated Household Survey, 1997–98.* Working Paper No. 16. *Poverty analysis of the Malawi Integrated Household Survey 1997–98.* Zomba, Malawi: Poverty Monitoring System, Government of Malawi.

Government of Malawi. 2000. *Integrated Household Survey 1997–98 draft report: Statistical abstract.* Zomba, Malawi: National Statistical Office.

Mozambique 1996

Survey Name and Dates

Mozambique *Inqerito Nacional aos Agregados Familiareas Sobre As Condicoes de Vida* (MIAF) (National Household Survey on Living Conditions) February 1996–April 1997

Data Collection Agency

Instituto Nacional de Estatistica (INE)

Sample Design and Size

A three-stage stratified sampling design was used.

The strata are the country's 10 provinces divided into urban and rural areas plus one additional stratum consisting of Maputo city.

In rural areas, the first-stage primary sampling units (PSUs) are *localidades.* The second-stage units are *aldeias,* with three to four selected within each *localidade.* The third-stage units are households, with nine selected within each of the *aldeias.*

In the urban provincial capitals and Maputo city, the PSUs are *bairros.* The second-stage units are *quarterões.* The third-stage units are households, with 12 selected within each *quarteirão.*

The total sample size was 8,273 households.

Food Data Collection

Households were asked to report the quantity in local units, unit of measure, and value of food acquired from purchases, own production, and transfers received for 271 food items. They were visited three times over a 7-day period. On each visit, the household was asked what food was acquired that day, as well as the preceding two days (on the second and third visits), so that food acquisition information was recorded separately for each of seven days. The recall period for food data collection was thus 2–3 days. The reference period was 7 days. The most common food items were precoded on the questionnaire, but the questions were open-ended, so that the household could include any food items that were acquired.

Calculation of Metric Food Quantities

For 12 percent of the cases, quantities of foods acquired were already reported in metric units.

For the rest, conversions to metric units took place using two main methods:

- Where quantities were reported in "unities," metric conversions were obtained from either a community price survey conducted in conjunction with the household survey or the AFINS project local unit conversion factor database (15 percent of the cases).
- Reported expenditures were divided by metric prices, with prices coming from the community price survey (70 percent of the cases) or estimated using metric or unitary unit values (4 percent).

For a small number of cases, weights of nonstandard units of measure were estimated using weights collected in other surveys undertaken in Sub-Saharan Africa.

Sources of Calorie Conversion Factors

The sources are, in order of decreased preference:

- *Tabela de Composição de Alimentos* (Mozambique 1991)
- *The composition of foods commonly eaten in East Africa* (West, Pepping, and Temalilwa 1988)
- *Food composition table for energy and eight important nutrients in foods commonly eaten in East Africa* (West 1987)
- *Composition of foods commonly eaten* (USDA 1998)
- *Food composition table for use in Africa* (Leung 1968)
- Tables from the University of California (no reference is listed for these tables)

Data Cleaning and Processing

Unit values were calculated for all observations and cleaned by examining the values for each food and region for outliers. If an outlier was detected, both the quantity and expenditure were set to missing.

The number of households dropped was 125, for the following reasons:

- More than 50 percent of the foods acquired had missing/outlier quantities (50 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (75 households).

The number of households for which calorie availability was estimated is 71, for the following reasons:

- Metric quantity could not be calculated for at least one food acquired (50 households).
- No food acquisitions were reported for the household (21 households).

The number of households included in the analysis is 8,148.

People Consulted

- Ken Simler, International Food Policy Research Institute, Washington, D.C.

Documents Consulted

Datt, G., K. Simler, S. Mukherjee, and G. Dava. 2000. *Determinants of poverty in Mozambique: 1996–97.* Food Consumption and Nutrition Division Discussion Paper No. 78. Washington, D.C.: IFPRI.

Ministry of Planning and Finance, Government of Mozambique / Universidade Eduardo Mondlane / International Food Policy Research Institute (MPF/UEM/IFPRI). 1998. *Understanding poverty and well-being in Mozambique: The first national assessment (1996–97).* Maputo:

Ministry of Planning and Finance; Washington, D.C.: International Food Policy Research Institute.

Rwanda 2000

Survey Name and Dates

Enquête Intégrale Sur les Conditions de Vie des Ménages au Rwanda: Urban areas, October 1999–December 2000; Rural areas: July 2000–July 2001.

Data Collection Agency

Direction de la Statistique du Ministere des Finances et de la Planification Economique (MINECOFIN).

Sample Design and Size

A two-stage stratified sampling design was employed.

The 13 strata are the 11 rural provinces, the capital city (Kigali), and a final group of the remaining cities in the country.

In rural areas, the first-stage primary sampling units (PSUs) are 40 villages (*cellules*). The second-stage unit is households, with 12 households selected within each village.

In urban areas, the PSUs are "zones" (80 from Kigali and 50 from other urban areas). The second-stage unit is households, with nine selected within each zone.

The sample size was 6,420.[51]

Food Data Collection

Households reported their expenditures on food purchases (for 126 foods) and quantities in local units of home-produced foods consumed (for 86 foods).[52] For home-produced foods, the unit of measure was also reported. In urban areas, food acquisition data were collected over 10 visits with 3-day recall periods each, giving a 30-day reference period. In rural areas, they were collected over seven visits with 2-day recall periods each, for a 14-day reference period.

Calculation of Metric Food Quantities

For food purchases, metric prices used in the calculation of Rwanda's consumer price index (CPI) were the primary source of prices used to convert purchase expenditures to metric quantities. These prices were originally collected in the provincial capitals on a bimonthly basis. However, only national average monthly prices (for January 2000–July 2001) were available for release by MINECOFIN. To account for price differences across provinces, province-level prices collected in January–February 2002 were used to compute adjustment factors, which were applied to the national-level prices before conversion to metric food quantities. CPI prices calculated at the following levels were used for the conversions: province–month (83.6 percent of all purchase observations), province (9.1 percent), month (4.1 percent), and national (0.2 percent).

A secondary source of metric prices used was those calculated from prices reported by households of items in standard-sized containers or directly in metric units (kilograms or liters) as part of the home-production portion of the survey. Prices calculated at the following levels were used for the conversions: province–month (0.2 percent), province (1 percent), and national (1.2 percent).

Finally, metric prices for a small number of food items (juices and spices) were calculated based on the relative price of a similar food item for which metric prices were available, with the relative price being calculated from other surveys undertaken in Sub-Saharan Africa (for example, the price of salt was used to estimate a price for

[51] Thirty households were dropped from the original sample of 6,450, 11 whose questionnaires were not filled in properly and the rest nonparticipants.

[52] They were asked the total value of food received as a gift in the previous 12 months. This was not taken into account in the computation of food security indicators.

pepper). This method was used for conversion of the remaining 0.6 percent of the purchase observations.

No metric prices were available for converting reported cash expenditures to metric quantities for 14 food items (0.8 percent of the total observations). They were converted using the same method used for converting food acquired outside of the home (the price per calorie of foods consumed inside of the home).

For home-produced food, reported quantities of food consumed in local units were converted to metric units using two methods. First, the reported quantities for some observations could be converted to metric quantities in a straightforward manner. These included observations where the household reported in kilograms, grams, or liters or in standard-sized containers (such as a 33 cl bottle) or in unities (such as "one banana"). They accounted for 47.2 percent of the total home-produced food observations. Second, for the remaining cases (52.8 percent), estimated expenditures were calculated as reported quantity multiplied by reported price per unit. Following, the CPI prices and metric prices derived from the home-production section of the survey were used to convert to metric quantities. The large majority of the observations for which this method was used (92 percent) were converted using region-month-level CPI prices.

Sources of Calorie Conversion Factors

The primary source employed is

- Food composition table for use in Africa (Leung 1968)

Secondary sources are

- *The composition of foods commonly eaten in East Africa* (West, Pepping, and Temalilwa 1988)
- *USDA nutrient database for standard reference,* release 15 (USDA 2002)
- *National food composition tables and the planning of satisfactory diets in Kenya* (Sehmi 1993)
- *Food composition table for use in Ethiopia* (Agren and Gibson 1968)
- *Aliments Africains: Table de composition* (Ndiaye 1993)

Data Cleaning and Processing

The CPI prices and those reported in standard units from the home-production portion of the survey were cleaned through comparison of prices for each food.

The number of households dropped was 55, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlier quantities (51 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (4 households).

The number of households for which calorie availability was estimated is 33, for the following reasons:

- Metric quantity could not be calculated for at least one food acquired (17 households).
- The calorie content of food prepared away from home could not be estimated (16 households).

The number of households included in the analysis is 6,365.

People Consulted

- Pacifique Ruty, Directeur de la Statistique, Ministere des Finances et de la Planification Economique (MINECOFIN)
- Oumar Saar, Expert Statistician, United Nations Development Program
- Edson Mpyisi, In-Country Coordinator, United States Agency for International Development and Michigan State University
- Christophe Rockmore, Operational Quality and Knowledge Services, Africa Region, The World Bank

Documents Consulted

Ministere des Finances et de la Planification Economique. Direction de la Statistique.

2002. *Rapport Final—Enquête Intégrale Sur les Conditions de Vie des Ménages au Rwanda 2000–2001.* Kigali, March 2002.

Ministry of Finance and Economic Planning, Republic of Rwanda. 2002. *A profile of poverty in Rwanda.* Kigali: National Poverty Reduction Programme and Statistics Department. February 2002.

Ambassade du Rwanda. 2002. Provinces, Villes et Districts. http://www.ambarwanda.be/Rwanda/pages/provinces.htm. (Accessed 10/1/2002).

Senegal 2002

Survey Name and Dates

Enquête Sénégalaise Aupres des Ménages (Round 2), February–May 2002

Data Collection Agency

Direction de la prévision et de la Statistique (DPS), Ministere de l'Economie et des Finances

Sample Design and Size

The data used for the analysis are from Round 2 of the data collection (out of two rounds total).

A two-stage stratified sampling design was used. The strata are the country's 10 regions broken into urban and rural areas. The first-stage primary sampling units are "districts de recensement" (DR), chosen from among those identified in the Recensement General de la Population et de l'Habitat for 2001. The second-stage units are households, with around 12 selected from each of the DRs.

Note that 44 DRs in the region of Ziguinchor were inaccessible "pour des raisons d'insecurite," and 22 DRs in the region of Tambacounda had a "lack of reliable information." These DRs were excluded from the sampling base, and their absence was corrected for before the sample was drawn.

The total sample size for Round 2 of the data collection is 6,052 households.[53]

Food Data Collection

Households reported the quantities, unit of measure, and value of foods acquired from purchases, own production, barter and in kind, and nonagricultural businesses for 258 food items.

For purchases, a diary was given to qualifying literate members of the household or their literate alternates. An enumerator visited the household every 3 days, checking the diary and copying the entries onto the questionnaire. If nobody in the household was literate, then the enumerator collected the information at each visit (that is, the interview method was used). Thus, for food purchases, the recall period is 1 or 3 days (where "1" assumes those using the diary fill it in on a daily basis). For the three other sources of food acquisition, only the interview method was used, and the recall period was 3 days.

The reference period differs for urban and rural areas. In urban areas, each household was visited 10 times by the enumerator, who recorded food acquisitions for the last 3 days. Thus, the reference period was 30 days. In rural areas, each household was visited five times,[54] giving a reference period of 21 days. Note that in practice, some households were visited fewer times, and this was taken into account in the calculation of daily values.

[53] The number of households in the data set released is 6,081. However, 29 were dropped from the analysis because these households contained no members who were in residence during the month of the survey.

[54] Although the documentation lists the number of visits to be seven, in Round 2 of the survey, the large majority of rural households were visited only five times.

Calculation of Metric Food Quantities

Metric quantities were available in the data set for 74 percent of the cases.[55] For the remaining cases, reported expenditures were divided by metric prices, where the prices are estimated using household-level unit values (reported expenditures divided by metric quantities) (25 percent) or estimated prices of similar foods (1 percent).

Sources of Calorie Conversion Factors

The primary source is

- *Aliments Africains: Table de composition* (Senegal) (Ndaiye 1993)

Secondary sources are:

- *The composition of Malian foods* (Nordeide 2003)
- *USDA nutrient database for standard reference,* release 15 (USDA 2002)
- *National food composition tables and the planning of satisfactory diets in Kenya* (Sehmi 1993)
- Conversion factors provided by the Food and Agriculture Organization of the United Nations used for FAO's food balance sheet calculations
- *Food composition table for use in Africa* (Leung 1968)
- *Composition of foods commonly used in Ghana* (Eyeson and Ankrah 1975)
- *Tables of representative values of foods commonly used in tropical countries* (Platt 1962)

Data Cleaning and Processing

Household-level unit values were manually examined for each food by region. For outlying observations, both the recorded expenditure and quantity were set to missing.

The number of households dropped was 45 for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (43 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (2 households).

The number of households for which calorie availability was estimated is 325, for the following reasons:

- Metric quantity could not be estimated for at least one food acquired (31 households).
- The calorie content of food prepared away from home could not be estimated (25 households).
- No food acquisitions were reported for the household (269 households).

The number of households included in the analysis is 6,007.

People Consulted

- Mr. Momar Sylla, Statistician, DPS
- Mr. Sogué Diarisso, Director, DPS

Documents Consulted

Direction de la Prévision et de la Statistique. 2001. *Enquête Sénégalaise Aupres des Ménages (ESAM, 2001): Manuel de l'agent enquêteur.* Ministere de l'Economie et des Finances, Republique du Senegal.

Direction de la Prévision et de la Statistique. 2001. *Enquête Sénégalaise Aupres des Ménages (ESAM): Nomenclatures.* Ministere de l'Economie et des Finances, Republique du Senegal.

Direction de la Prévision et de la Statistique. 2001. *Enquête Sénégalaise Aupres des Ménages (ESAM): Plan de sondage.* Ministere de l'Economie et des Finances, Republique du Senegal.

Direction de la Prévision et de la Statistique. 2001. *Questionnaire unifié sur les indi-*

[55] It is not clear whether the households actually reported in metric quantities or enumerators weighed foods during data collection.

cateurs de développement (QUID). Ministere de l'Economie et des Finances, Republique du Senegal.

Tanzania 2000

Survey Name and Dates

The Tanzanian Household Budget Survey (HBS) May 2000 to June 2001

Data Collection Agency

National Bureau of Statistics (NBS) Tanzania

Sample Design and Size

A two-stage stratified sampling design was used.

The strata are the country's 20 regions, each divided into urban and rural areas. In the rural areas, further stratification was undertaken into "normal," "large town surrounding," and "low density" areas. Urban areas were further stratified into districts.

In rural areas, the first-stage primary sampling unit (PSU) is villages. The second-stage unit is households, with 24 selected from each village.

In urban areas, the PSUs are census enumeration areas (EAs). The second-stage unit is households, with 24 selected from each EA.

The total sample size was 22,178 households.

Food Data Collection

Households reported quantities and expenditures on food purchases and food acquired from home production, transfers from other households, and payments in kind for work for 129 food items. The reference period was 1 month. To facilitate recall, a daily diary was used. If a literate household member was available, this person maintained the diary and then submitted it to the enumerator every 2–3 days to be entered into the main questionnaire. If not, then the enumerator visited the household on a daily basis to maintain the diary. In addition to the diary, adult household members were given a personal diary that they used to record their personal expenditure outside the household. This information was later added to the diary. The enumerators carried mobile scales with them and weighed food items so as to record them in metric units.

Calculation of Metric Food Quantities

For most of the cases (98.9 percent), the quantities of food items were recorded in metric units by the enumerators after field weighing of items reported in local units of measure by households. For some cases, expenditure divided by estimated metric prices was employed (0.58 percent), where prices are estimated using cleaned metric unit values. This method was used where (1) an expenditure was reported but not quantity, or (2) the local unit of measure reported in was deemed to have widely varying sizes. For the remaining cases (0.51 percent), households reported quantities of foods acquired in "unities" (for example, one egg), and USDA medium metric weights were used for the conversions (USDA 2002).

Sources of Calorie Conversion Factors

The primary source employed is

- *Food composition table for use in Africa* (Leung 1968)

Secondary sources are

- *The composition of foods commonly eaten in East Africa* (West, Pepping, and Temalilwa 1988)
- *USDA nutrient database for standard reference,* release 15 (USDA 2002)
- *National food composition tables and the planning of satisfactory diets in Kenya* (Sehmi 1993)
- Conversion factors provided by the Food and Agriculture Organization of the United Nations used for FAO's food balance sheet calculations

Data Cleaning and Processing

Household-level unit values (reported expenditure divided by metric quantity) were manually examined for each food, by region and district, for outliers. For outlying observations, both the recorded expenditure and quantity were set to missing.

The number of households dropped was 528, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (19 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (509 households).

The number of households for which calorie availability was estimated is 146, for the following reason:

- The calorie content of food prepared away from home could not be estimated.

The number of households included in the analysis is 21,650.

People Consulted

- Mr. Mkai, Director General, NBS of Tanzania
- Mr. Abdulrahaman Kaimu, Director of Social Statistics, NBS of Tanzania
- Mr. Aboud, NBS of Tanzania
- Mr. Swebe, NBS of Tanzania
- Mr. Justus Kabyemera, Program Assistant, Food and Agricultural Organization of the United Nations, Tanzania Office

Documents Consulted

National Bureau of Statistics. 2002. *Household budget survey 2000/01.* Dar es Salaam: National Bureau of Statistics Tanzania.

Uganda 1999

Survey Name and Dates

Uganda National Household Survey 1999/2000, August 1999 to July 2000

Data Collection Agency

Uganda Bureau of Statistics (UBS)

Sample Design and Size

A combination of two- and three-stage stratified sampling designs was used.

The strata are the country's districts divided into three areas: "urban," "other urban,"[56] and "rural."

Within most strata, a two-stage sampling design was used. The first-stage primary sampling units (PSUs) are enumeration areas (EAs) of the 1991 Population Census. The second-stage unit is households, with 10 selected from each EA.

For the remaining strata, an enumeration sampling frame was not available from the census. A three-stage sampling design was used. The PSUs are parishes, and the second-stage unit is villages. The third-stage unit is households, with 10 selected from each village.

The total sample size was 10,696 households.

Note that out of 45 districts in the country, 4 were excluded from the survey (Kitgum, Gulu, Kasese, and Bundibugyo) because of accessibility problems.

Food Data Collection

During a single interview, households were asked to report the quantity in local units, unit of measure, and value of food acquired from purchases, consumption of home production, and gifts over the last 7 days. The recall and reference periods for food data collection are thus both 1 week. The number of food categories is 152.

[56] For example, town boards and trading centers.

Calculation of Metric Food Quantities

For 26 percent of the cases, quantities of foods acquired were already reported in metric units.

For the rest, quantities acquired in local units were converted to metric units using local unit conversion factors (LUCFs) from the following sources:

- Collected by the UBS in two different surveys (41 percent of cases). The first was a survey of markets in urban, other urban, and rural areas of the country's four regions (Central, Eastern, Western, and Northern). The second was a survey of markets in the four regions, for agricultural products only.
- Derived from the UBS-collected LUCFs, taken from the AFINS project LUCF database, or estimated from the LUCF for a similar food (24 percent of cases).
- Estimated using a ratio of the household-level unit value of a food (with quantity measured in a local unit) to the median sample-level unit value of the food measured in grams (7 percent of cases).

Note that one food category, "infant formula foods," was dropped, as it was not possible to convert quantities to metric units.

Conversion to Calories

The primary source employed is

- *Food composition table for use in Africa* (Leung 1968)

Secondary sources are

- *The composition of foods commonly eaten in East Africa* (West, Pepping, and Temalilwa 1988)
- *National food composition tables and the planning of satisfactory diets in Kenya* (Sehmi 1993)
- *USDA nutrient database for standard reference,* release 15 (USDA 2002)

Data Cleaning and Processing

The LUCFs collected by the UBS were thoroughly cleaned by hand. Probable reporting and data entry errors in the quantities and expenditures were identified by computing unit values for each food and cleaning them by hand for urban and rural areas within each of the four provinces.

The number of households dropped was 106, for the following reasons:

- More than 50 percent of the foods acquired has missing/outlier quantities (70 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (36 households).

The number of households for which calorie availability was estimated is 609, for the following reasons:

- The calorie content of food prepared away from home could not be estimated (162 households).
- No food acquisitions were reported for the household (447 households).

The number of households included in the analysis is 10,590.

People Consulted

- James Muwonge, Principal Statistician, Uganda Bureau of Statistics

Documents Consulted

Uganda Bureau of Statistics. 2001. *Uganda National Household Survey 1999/2000: Report on the socio-economic.* Entebbe: Uganda Bureau of Statistics.

Uganda Bureau of Statistics. Undated. *Uganda National Household Survey 1999/2000: Manual of instructions.* Ministry of Finance, Planning and Economic Development. Entebbe: Uganda Bureau of Statistics.

Zambia 1996

Survey Name and Dates

Zambia Living Conditions Monitoring Survey I (1996), August to October 1996

Data Collection Agency

Central Statistical Office (CSO), Republic of Zambia

Sample Design and Size

Two-stage stratified random sampling was used.

The strata were identified as follows. The country was first broken down into urban and rural areas of the 57 districts[57] located within the country's nine provinces. An additional stage of stratification broke urban areas into three housing cost groups (low, medium, and high) and rural areas into type of activity (small-scale agricultural, medium-scale agricultural, large-scale agricultural, and nonagricultural). This latter stage of stratification was not taken into account in statistical calculations because many of the resulting strata did not contain more than one primary sampling unit.[58] A final stage of stratification, "centrality," is mentioned in the documentation, but no identification variable was included with the data set.

The first-stage primary sampling units were enumeration areas from the 1990 Census of Population and Housing. The second-stage units are households, with 15 selected in each rural EA and 25 in each urban EA.

The total sample size was 11,763.

Food Data Collection

Enumerators visited each household once, collecting information on food purchased and consumed from own production or "received." For purchased food items, the recall and reference periods were 1 month for maize grain and maize meal; they were 2 weeks for all other food items. Households were asked to report the total value of each food purchased over the recall period. For home-produced/received food items, the recall and reference periods were 2 weeks. Households were asked to report the quantity consumed, unit of measure, and price per unit.

Food data were collected for 28 food items. However, an expanded list of foods was extracted for the food data analysis because in many cases the "unit of measure" data collected were used to record information about the type of food within a broad food category. For example, from the category "Fruits," five food items could be extracted: lemons, bananas, oranges, papayas, and other fruits. The final number of food items used for the analysis is 40.

Note: Data were not collected on food eaten away from home.

Calculation of Metric Food Quantities

After consulting with statisticians at the CSO, it was determined that the local quantity data collected by enumerators as part of the home-produced/received section of the questionnaire was not reliable in its raw form. Enumerators were confused about how to enter the data. For example, in some cases, they entered the total expenditure on the item in place of the price. Thus, included with the data set was a variable representing the total expenditure on each food item as calculated by the original survey data analysts using their judgment and experience (for example, knowledge of prices in the country) to clean the data and compute expenditures. This is the final variable that was used in the data analysis of this study.

Given the above, the data employed for conversion to metric quantities were expenditures for both purchases and home-

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[57]At the time of the survey, the country's five additional districts had not yet been gazetted.

[58]Ninety-five of the 272 strata have only one primary sampling unit, prohibiting use of STATAs "survey" commands to correct for the sampling design (StataCorp 2003).

produced/received food items. Expenditures were divided by metric prices derived from August 1996 Consumer Price Index prices collected at the market level and provided by the CSO.[59] The market-level prices were used to calculate prices at more aggregate levels in order to match the geographic location of the households.

Sources of Calorie Conversion Factors

The primary source employed is

- *Food composition table for use in Africa* (Leung 1968)

Secondary sources are

- *USDA nutrient database for standard reference,* release 15 (USDA 2002)
- *National food composition tables and the planning of satisfactory diets in Kenya* (Sehmi 1993)
- Conversion factors provided with the Ethiopia data set (see methodology documentation for Ethiopia 1999)
- Conversion factors provided by the Food and Agriculture Organization of the United Nations used for FAO's food balance sheet calculations
- *The composition of foods commonly eaten in East Africa* (West, Pepping, and Temalilwa 1988).

Data Cleaning and Processing

CPI prices were cleaned through comparison of prices for each food across markets.

The number of households dropped was 180, for the following reasons:

- More than 50 percent of the foods acquired had missing or outlying metric quantities (24 households).
- The calorie availability per adult equivalent was greater than 12,000 kilocalories (156 households).

The number of households for which calorie availability was estimated is 22, for the following reasons:

- Metric quantity could not be calculated for at least one food acquired (one household).
- No food acquisitions were reported for the household (21 households).

The number of households included in the analysis is 11,583.

People Consulted

- Mr. Kamocha, Mr. Tembo, Mr. Kakungu, Mrs. Nkombo, and Nkombo Nchimunya, CSO

Documents Consulted

Central Statistical Office. undated. *Living conditions monitoring survey—I 1996: Survey design/logistics.* Lusaka, Republic of Zambia: Central Statistical Office.

Central Statistical Office. undated. *Living conditions monitoring survey—I 1996: Data user's guide.* Lusaka, Republic of Zambia: Central Statistical Office.

[59] For a small number of food items, prices that were not available in the CPI price series were imputed from 2002 prices collected in a Lusaka market. The imputation took place by taking the ratio of the 2002 price of the missing-price food with the 2002 price of similar food for which the price was available in 1996. This ratio was then used to impute the missing food's price.

APPENDIX C

Standard Errors for Estimates of Food Security Measures

Table C.1 Standard errors for estimates of food energy availability

Country	Year	Food energy availability per capita	Standard error	95% Confidence interval	
				Lower limit	Upper limit
Burundi	1998	1,592	27.9	1,537	1,646
Ethiopia	1999	1,648	17.3	1,614	1,682
Ghana	1998	2,328	51.8	2,226	2,430
Guinea	1994	2,510	56.5	2,398	2,621
Kenya	1997	2,579	29.4	2,521	2,636
Malawi	1997	1,614	49.4	1,516	1,711
Mozambique	1996	2,059	36.0	1,988	2,130
Rwanda	2000	1,860	29.8	1,801	1,918
Senegal	2001	1,967	28.0	1,912	2,022
Tanzania	2000	2,454	35.3	2,384	2,523
Uganda	1999	2,636	27.0	2,583	2,689
Zambia	1996	1,764	23.9	1,718	1,811

Note: All values are corrected for survey sampling designs.

Table C.2 Standard errors for estimates of food energy deficiency

Country	Year	Percentage of people food energy deficient	Standard error	95% Confidence interval	
				Lower limit	Upper limit
Burundi	1998	74.8	1.1	72.7	77.0
Ethiopia	1999	76.4	1.0	74.4	78.4
Ghana	1998	51.4	1.9	47.6	55.2
Guinea	1994	45.1	1.8	41.6	48.6
Kenya	1997	43.9	1.0	42.0	45.8
Malawi	1997	73.3	1.6	70.0	76.4
Mozambique	1996	60.3	1.2	58.1	62.6
Rwanda	2000	65.3	1.1	63.2	67.4
Senegal	2001	60.2	1.2	57.8	62.6
Tanzania	2000	43.9	1.4	41.2	46.6
Uganda	1999	36.8	1.0	34.9	38.8
Zambia	1996	71.1	0.8	69.5	72.7

Note: All values are corrected for survey sampling designs.

Table C.3 Standard errors for estimates of household dietary diversity

Country	Year	Household dietary diversity	Standard error	95% Confidence interval	
				Lower limit	Upper limit
Burundi	1998	4.5	0.046	4.38	4.57
Ethiopia	1999	4.8	0.031	4.77	4.90
Ghana	1998	5.8	0.032	5.77	5.90
Guinea	1994	6.0	0.037	5.94	6.09
Kenya	1997	5.4	0.031	5.31	5.43
Malawi	1997	4.4	0.063	4.26	4.51
Mozambique	1996	4.2	0.032	4.15	4.27
Rwanda	2000	4.5	0.031	4.48	4.60
Senegal	2001	5.9	0.029	5.85	5.96
Tanzania	2000	5.9	0.034	5.83	5.96
Uganda	1999	4.4	0.029	4.35	4.46
Zambia	1996	4.6	0.031	4.55	4.67

Note: All values are corrected for survey sampling designs.

Table C.4 Standard errors for estimates of the prevalence of low diet diversity

Country	Year	Percentage of households with low diet diversity	Standard error	95% Confidence interval	
				Lower limit	Upper limit
Burundi	1998	44.0	1.4	41.3	46.7
Ethiopia	1999	36.4	1.1	34.1	38.6
Ghana	1998	8.0	0.80	6.4	9.6
Guinea	1994	7.7	1.0	5.8	9.7
Kenya	1997	25.0	0.83	23.4	26.6
Malawi	1997	49.8	2.5	44.9	54.8
Mozambique	1996	62.6	1.67	59.3	65.9
Rwanda	2000	49.2	1.06	47.2	51.3
Senegal	2001	8.1	0.58	6.9	9.2
Tanzania	2000	9.7	0.97	7.8	11.6
Uganda	1999	50.9	0.91	49.1	52.7
Zambia	1996	43.7	1.02	41.7	45.7

Note: All values are corrected for survey sampling designs.

APPENDIX D

Country Food Security Profiles

Table D.1 Food security profile for Burundi, 1998

Variable	Food energy availability: Energy availability per capita	Food energy availability: Percentage of people food energy deficient	Diet quality: Household dietary diversity (over 2 weeks)	Diet quality: Percentage of households with low diet diversity	Diet quality: Percentage of energy from staples	Vulnerability: Percentage of expenditures on food
National	1,592	74.8	4.5	44.0	62.3	76.1
Regional						
Bujumbura	2,678	41.4	5.9	6.5	52.8	57.7
Plaines	1,410	80.3	4.0	56.7	62.1	76.1
Montagne	1,594	77.0	4.5	43.8	66.8	74.4
Plateaux Occidentaux	1,533	75.2	4.6	38.1	63.4	80.5
Plateaux Orientaux	1,561	74.0	4.3	49.3	56.0	78.0
Rural	1,533	76.6	4.4	46.0	62.8	77.1
Urban	2,678	41.4	5.9	6.5	52.8	57.7
Expenditure quintile						
1	1,193	85.9	3.9	60.4	66.1	79.2
2	1,508	77.6	4.6	42.5	63.8	77.8
3	1,810	68.6	4.7	37.1	60.0	75.2
4	2,330	54.3	5.0	[25.6]	56.7	71.8
5	3,683	[13.9]	5.7	[15.7]	52.0	59.5
Male-headed household	1,650	73.6	4.7	39.2	61.9	75.9
Female-headed household	1,386	79.0	4.0	57.6	63.6	76.7

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

Table D.2 Food security profile for Ethiopia, 1999

Variable	Food energy availability		Diet quality			Vulnerability
	Energy availability per capita	Percent of people food energy deficient	Household dietary diversity (over 2 weeks)	Percent of households with low diet diversity	Percent of energy from staples	Percent of expenditures on food
National	1,648	76.4	4.8	36.4	83.2	63.1
Regional						
Tigray	1,663	75.3	4.8	[34.3]	85.4	65.9
Affar	1,370	90.4	4.4	46.3	77.3	63.5
Amhara	1,725	72.7	4.1	58.5	82.0	66.6
Oromiya	1,670	74.8	5.1	26.0	84.0	62.6
Somalie	1,565	85.7	4.6	[40.9]	76.1	61.1
Benishangul Gumuz	1,836	66.2	5.2	[28.2]	81.7	62.9
SNNPR	1,529	81.9	5.1	29.4	85.5	60.4
Gambela	1,624	80.1	4.7	[42.9]	83.1	57.2
Harari	1,738	75.3	5.9	[8.6]	77.5	59.9
Addis Ababa	1,542	86.9	5.5	14.6	72.8	52.0
Dire Dawa	1,611	81.5	5.3	[19.6]	76.5	67.8
Rural	1,680	74.4	4.7	40.0	84.6	64.7
Urban	1,444	89.2	5.5	15.2	75.1	54.0
Expenditure quintile						
1	1,558	79.9	4.9	34.8	85.5	65.5
2	1,695	72.3	4.7	43.1	84.5	65.2
3	1,769	72.1	4.7	39.4	82.7	62.6
4	1,757	76.1	5.0	32.8	79.7	58.3
5	1,827	73.3	5.6	12.3	71.3	49.2
Male-headed household	1,653	76.4	4.9	34.6	83.3	63.6
Female-headed household	1,628	76.2	4.7	41.5	83.1	61.7

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

Table D.3 Food security profile for Ghana, 1998

	Food energy availability		Diet quality			Vulnerability
Variable	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity (over 2 weeks)	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	2,328	51.4	5.8	8.0	66.9	61.4
Regional						
Western	2,496	[44.0]	5.9	[7.6]	70.8	60.2
Central	2,011	62.8	5.7	[7.5]	66.4	64.4
Greater Accra	2,345	[52.1]	6.2	[7.4]	58.8	50.7
Eastern	2,361	52.4	5.9	[5.4]	74.4	61.7
Volta	2,386	49.3	5.9	[4.7]	71.3	63.7
Ashanti	2,325	49.4	5.8	[12.2]	64.8	57.0
Brong Ahafo	2,456	[47.3]	5.9	[5.6]	65.9	66.1
Northern	[2,305]	[53.2]	5.3	[13.3]	68.2	67.7
Upper East	2,162	[57.2]	5.4	[3.8]	68.2	74.8
Upper West	2,158	[56.9]	5.4	[6.9]	62.5	75.1
Rural	2,358	50.5	5.7	[7.6]	70.6	65.8
Urban	2,269	53.1	6.0	[8.6]	60.7	54.0
Expenditure quintile						
1	1,973	62.6	5.6	[7.0]	73.0	69.8
2	2,177	55.5	5.8	[5.2]	71.2	65.2
3	2,405	47.5	5.9	[5.6]	68.1	62.2
4	2,588	42.9	6.0	[8.1]	64.8	58.2
5	3,189	[29.2]	5.9	[13.7]	57.9	51.9
Male-headed household	2,327	52.4	5.8	[8.5]	66.5	61.1
Female-headed household	2,333	48.7	5.9	[6.9]	67.8	62.1

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

Table D.4 Food security profile for Guinea, 1994

	Food energy availability		Diet quality			Vulnerability
Variable	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity[a]	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	2,510	45.1	6.0	[7.7]	66.3	55.6
Region						
Conakry	2,174	57.6	6.6	[5.1]	51.4	39.2
Basse Guinee	2,402	46.4	6.0	[6.9]	66.7	55.7
Moyenne Guinee	2,491	46.0	5.9	[9.0]	69.8	62.7
Haute Guinee	2.302	49.3	5.6	[12.5]	73.7	57.2
Guinee Forestiere	3,192	[26.5]	6.1	[4.2]	67.1	58.9
Rural	2,645	40.6	5.8	[9.7]	71.3	61.7
Urban	2,234	54.3	6.6	[3.5]	55.4	42.4
Expenditure quintile						
1	2,296	50.3	5.6	[12.2]	73.8	62.6
2	2,794	34.9	6.0	[5.8]	70.2	60.2
3	2,563	45.7	6.4	[1.5]	61.6	52.0
4	2,371	53.2	6.5	[4.6]	55.4	44.3
5	2,984	32.8	6.4	[9.0]	49.0	36.5
Male-headed household	2,496	45.6	6.0	[6.9]	66.4	55.2
Female-headed household	2,625	40.7	5.9	[12.0]	65.9	57.9

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

[a]The reference period for urban areas is 30 days; for rural areas, it is 14 days.

Table D.5 Food security profile for Kenya, 1997

	Food energy availability		Diet quality			Vulnerability
Variable	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity (over 1 week)	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	2,579	43.9	5.4	25.0	61.8	74.8
Region						
Nairobi	3,006	[34.1]	6.0	[11.8]	52.1	53.9
Central	2,858	33.5	5.6	18.5	62.8	74.3
Coast	3,043	34.3	5.1	31.9	59.7	73.5
Eastern	2,552	42.9	5.3	27.0	65.8	78.0
Nyanza	2,461	49.2	5.3	26.7	64.6	82.4
Rift Valley	2,402	47.9	5.3	27.9	60.5	73.3
Western	2,233	53.9	5.2	28.8	63.0	80.4
Rural	2,473	46.3	5.2	28.2	63.9	78.7
Urban	3,168	30.2	5.9	12.0	53.3	59.0
Expenditure quintile						
1	2,095	57.3	5.1	30.8	67.1	84.6
2	2,303	49.5	5.1	31.7	64.9	82.1
3	2,522	45.1	5.3	26.3	63.2	77.6
4	2,935	31.2	5.6	20.6	61.2	72.6
5	3,659	[21.4]	5.8	16.8	54.0	59.8
Male-headed household	2,581	45.2	5.4	23.4	61.2	73.1
Female-headed household	2,572	39.7	5.2	29.0	63.3	79.0

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

Table D.6 Food security profile for Malawi, 1997

	Food energy availability		Diet quality			Vulnerability
Variable	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity[a]	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	1,614	73.3	4.4	49.8	69.4	68.4
Region						
South	1,489	77.0	4.5	44.5	68.9	68.7
Central	1,711	69.9	4.2	57.2	70.6	69.1
North	1,768	70.2	4.5	45.9	66.5	64.4
Rural	1,621	73.0	4.2	53.6	71.5	71.6
Urban	1,533	76.3	5.7	[16.8]	51.4	40.9
Expenditure quintile						
1	1,289	82.0	4.0	63.1	72.4	77.7
2	1,475	77.5	4.0	61.9	72.2	76.3
3	1,721	71.0	4.2	53.3	73.1	72.1
4	1,890	64.9	4.5	44.0	69.6	65.3
5	1,852	66.3	5.3	25.7	57.4	47.2
Male-headed household	1,631	73.1	4.5	47.3	69.2	66.7
Female-headed household	1,546	74.2	4.2	57.6	69.8	73.7

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

[a]The reference period for food purchases is 1 month for the large majority of households; for home-produced food and food received in kind, it is 3 days.

Table D.7 Food security profile for Mozambique, 1996

	Food energy availability		Diet quality			Vulnerability
Variable	**Energy availability per capita**	**Percentage of people food energy deficient**	**Household dietary diversity (over 1 week)**	**Percentage of households with low diet diversity**	**Percentage of energy from staples**	**Percentage of expenditures on food**
National	2,059	60.3	4.2	62.6	77.3	67.9
Region						
Niassa	2,135	56.9	3.6	86.6	80.0	67.6
Cabo Delgado	1,673	74.2	4.0	76.4	80.3	65.0
Nampula	1,838	65.2	4.0	74.8	78.9	75.8
Zambezia	2,269	53.3	4.4	48.6	82.3	65.3
Tete	1,894	66.4	4.0	72.2	74.2	75.0
Manica	2,405	48.6	4.0	68.3	84.7	71.7
Sofala	[1,312]	76.2	4.2	62.2	69.4	61.2
Inhambane	1,486	78.9	4.4	58.1	62.4	69.1
Gaza	2,956	[35.8]	3.9	72.6	80.8	67.2
Maputo	1,802	65.6	4.3	53.9	72.2	56.5
Maputo (Capital City)	3,427	33.2	5.8	[6.4]	71.7	62.4
Rural	1,935	62.9	4.0	70.1	77.8	69.2
Urban	2,524	50.7	5.1	29.3	75.2	62.2
Expenditure quintile						
1	1,603	72.4	3.9	74.7	77.8	75.3
2	1,845	65.5	4.0	72.1	79.1	71.3
3	1,969	62.2	4.1	65.4	77.9	67.8
4	2,301	51.5	4.4	52.4	76.6	63.7
5	3,371	31.9	4.9	36.3	73.3	57.3
Male-headed household	2,045	60.8	4.2	62.6	77.4	67.9
Female-headed household	2,124	58.2	4.2	62.4	77.1	68.3

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

Table D.8 Food security profile for Rwanda, 2000

Variable	Food energy availability		Diet quality			Vulnerability
	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity[a]	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	1,860	65.3	4.5	49.2	62.6	81.6
Region						
Butare	1,519	78.2	4.7	43.3	60.1	81.6
Byumba	1,855	67.7	4.2	60.8	55.1	85.3
Cyangugu	1,365	80.7	5.3	[21.2]	56.1	83.7
Gikongor	1,721	70.9	3.9	65.5	69.7	85.9
Gisenyi	1,742	68.6	4.5	46.9	66.5	82.9
Gitarama	2,191	53.2	4.7	42.9	66.2	80.9
Kibungo	2,334	48.5	4.7	45.4	65.3	80.8
Kibuye	1,583	76.0	4.1	64.3	63.9	89.3
Kigali Ngali	2,076	57.6	4.2	60.3	63.9	83.3
Ville de Kigali	2,173	56.2	6.4	[3.3]	52.6	57.2
Ruhengeri	1,669	70.3	3.9	67.6	65.8	84.7
Umutara	1,917	63.3	4.2	61.9	64.1	81.3
Rural	1,824	66.5	4.3	54.1	63.6	84.2
Urban	2,159	55.4	6.3	[4.9]	53.4	58.6
Expenditure quintile						
1	1,378	80.8	4.0	65.3	66.1	87.8
2	1,612	73.4	4.2	59.4	64.0	86.7
3	1,944	61.9	4.5	48.2	63.5	83.7
4	2,161	55.9	4.7	43.8	61.6	79.4
5	2,634	41.1	5.7	18.6	55.1	64.8
Male-headed household	1,903	64.1	4.7	45.2	62.0	81.0
Female-headed household	1,746	68.6	4.3	57.9	63.8	83.1

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.
[a]The reference period for urban areas is 30 days, and the one for rural areas is 14 days.

Table D.9 Food security profile for Senegal, 2001

Variable	Food energy availability: Energy availability per capita	Food energy availability: Percentage of people food energy deficient	Diet quality: Household dietary diversity	Diet quality: Percentage of households with low diet diversity	Diet quality: Percentage of energy from staples	Vulnerability: Percentage of expenditures on food
National	1,967	60.2	5.9	8.1	55.5	61.0
Region						
Dakar	1,803	70.6	6.2	[5.2]	48.3	53.2
Zinguinchor	1,430	82.7	5.2	[28.6]	59.1	55.4
Diourbel	2,066	[53.7]	5.9	[5.2]	60.7	66.3
Saint-Louis	1,800	64.7	6.0	[5.0]	49.0	65.3
Tambacouda	2,298	[42.1]	5.7	[9.3]	60.8	65.4
Kaolack	2,222	47.9	5.8	[6.2]	64.5	64.1
Thies	1,994	59.6	6.1	[3.4]	55.8	65.0
Louga	2,130	54.9	5.9	[7.9]	48.8	63.5
Fatick	2,183	48.9	5.8	[6.0]	64.6	54.6
Kolda	1,948	62.0	5.5	[19.8]	60.5	64.3
Rural	2,065	54.3	5.6	[11.0]	60.0	65.5
Urban	1,827	68.5	6.3	[4.3]	49.7	55.0
Expenditure quintile						
1	1,885	59.0	5.6	[11.4]	63.4	66.2
2	1,985	56.2	5.8	[6.8]	58.8	66.0
3	2,102	58.7	6.0	[5.7]	55.0	63.1
4	1,898	64.2	6.3	[4.9]	51.2	58.1
5	2,172	53.2	5.9	[11.8]	46.1	48.0
Male-headed household	1,986	59.5	5.9	[8.2]	56.4	61.9
Female-headed household	1,868	63.7	6.1	[7.4]	51.9	56.7

Note: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value.

Table D.10 Food security profile for Tanzania, 2000

	Food energy availability		Diet quality			Vulnerability
Variable	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity (over 1 month)	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	2,454	43.9	5.9	9.7	70.6	72.5
Region						
Dodoma	2,764	[29.6]	6.0	[5.2]	74.5	73.2
Arusha	2,307	[52.3]	6.0	[13.3]	68.6	73.9
Kilimanjaro	2,043	61.0	6.3	[3.4]	61.1	79.3
Tanga	2,379	[46.6]	5.9	[13.1]	72.5	73.9
Morogoro	2,463	[42.1]	6.0	[5.1]	72.1	75.6
Pwani	2,339	52.5	5.8	[4.9]	68.6	73.7
Dar es Salaam	2,079	61.0	6.1	[8.1]	57.9	60.8
Lindi	[2,558]	[51.5]	5.3	[20.5]	70.4	78.3
Mtwara	2,648	[44.0]	5.5	[15.4]	68.1	73.3
Ruvuma	2,557	[42.2]	5.3	[18.7]	76.5	68.6
Iringa	2,575	[43.8]	5.8	[10.0]	71.4	78.2
Mbeya	2,659	[27.1]	6.3	[4.4]	69.5	71.5
Singida	2,249	[49.1]	5.6	[18.1]	73.9	77.2
Tabora	2,936	[22.3]	6.2	[2.6]	73.2	74.0
Rukwa	2,283	[53.9]	5.9	[5.1]	72.6	69.2
Kigoma	2,482	47.8	5.9	[2.0]	72.1	70.8
Shinyanga	2,776	[30.2]	5.9	[8.0]	77.3	71.7
Kagera	2,289	[45.7]	5.9	[12.9]	65.2	73.0
Mwanza	2,311	47.2	5.7	[11.1]	76.3	68.6
Mara	[2,215]	[57.1]	5.6	[20.3]	73.2	72.0
Rural	2,487	41.8	5.8	[11.0]	72.8	74.4
Urban	2,314	52.7	6.2	[5.1]	62.5	65.5
Expenditure quintile						
1	2,246	49.3	5.7	[13.1]	76.4	75.7
2	2,562	39.5	5.9	[10.1]	71.9	74.5
3	2,613	39.4	6.1	[5.5]	68.6	71.6
4	2,543	43.2	6.1	[5.5]	64.1	67.6
5	3,015	35.9	6.0	[9.5]	59.3	64.4
Male-headed household	2,460	44.2	5.9	[9.6]	70.7	72.7
Female-headed household	2,427	42.8	5.9	[10.1]	69.9	71.8

Notes: Square brackets indicate a 95 percent confidence interval whose limits are more than 20 percent from the value. The highest difference between the confidence interval limits and the value is 35 percent for the percentage of people food energy deficient in the region of Lindi.

Table D.11 Food security profile for Uganda, 1999

	Food energy availability		Diet quality			Vulnerability
Variable	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity (over 1 weeks)	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	2,636	36.8	4.4	50.9	69.4	59.3
Region						
Central	2,632	36.9	4.7	41.9	66.7	54.6
Eastern	2,602	32.3	4.6	42.3	72.1	61.5
Northern	2,087	58.1	4.1	61.0	64.7	63.0
Western	3,089	25.5	4.0	64.5	73.6	60.1
Rural	2,658	36.3	4.2	56.5	71.6	61.3
Urban	2,493	40.7	5.3	21.1	57.4	48.7
Expenditure quintile						
1	2,187	49.8	4.1	61.9	71.3	65.5
2	2,681	31.8	4.1	58.7	73.2	62.8
3	2,771	32.1	4.3	53.9	72.4	59.2
4	3,012	29.9	4.6	44.2	69.1	55.9
5	2,941	31.6	5.0	30.2	59.3	50.1
Male-headed household	2,687	34.7	4.5	48.6	69.1	59.5
Female-headed household	2,460	44.4	4.2	57.2	70.1	58.9

Table D.12 Food security profile for Zambia, 1996

	Food energy availability		Diet quality			Vulnerability
Variable	Energy availability per capita	Percentage of people food energy deficient	Household dietary diversity[a]	Percentage of households with low diet diversity	Percentage of energy from staples	Percentage of expenditures on food
National	1,764	71.1	4.6	43.7	78.0	66.2
Region						
Central	2,014	60.9	4.6	43.2	80.9	62.9
Copperbelt	1,832	70.9	5.4	16.7	72.9	63.8
Eastern	1,644	75.5	4.4	52.7	83.6	71.5
Luapula	1,604	76.3	4.1	63.1	86.2	65.2
Lusaka	1,823	70.5	5.6	13.2	71.2	56.9
Northern	1,394	79.7	4.2	57.0	72.4	71.7
Northwestern	2,067	60.6	4.0	64.4	82.4	73.6
Southern	1,774	70.9	4.4	48.3	79.1	62.0
Western	1,869	68.0	3.2	80.8	85.2	76.2
Rural	1,750	71.2	4.1	60.9	82.0	70.3
Urban	1,788	70.9	5.6	11.8	70.7	58.7
Expenditure quintile						
1	1,475	79.9	4.0	64.0	83.4	72.4
2	1,722	71.6	4.2	54.7	81.8	68.9
3	1,847	67.9	4.7	40.5	77.4	65.4
4	1,958	66.8	5.2	24.1	72.8	61.0
5	2,445	50.7	5.7	14.4	67.4	57.8
Male-headed household	1,762	71.5	4.7	40.8	77.4	65.8
Female-headed household	1,774	69.2	4.3	53.1	80.0	67.6

[a]The reference period for purchases of maize is 30 days; for other purchased foods and foods from other sources, it is 14 days.

APPENDIX E

Methods of Estimating Global and Regional Food Energy Deficiency Prevalences when Data Are Not Available for All Countries

Let countries be indexed by $i = 1, \ldots, N$. The countries for which household survey data exist are denoted $C_1, \ldots, C_m$. Those for which household survey data do not exist are denoted $C_{m+1}, \ldots, C_N$.

Method 1: Extrapolations Based on Cross-Country Regression

This method draws on the extrapolation technique employed to estimate national poverty rates by the World Bank's Global Poverty Monitoring Facility. The estimation relies on individual country-specific characteristics for estimating energy deficiency rates of countries for which survey data do not exist.

The extrapolations are undertaken using cross-country Ordinary Least Squares regressions in which the regressors are variables describing various economic, social, political, and demographic factors related to food insecurity. Candidates for these factors may be:

- arable and irrigated land areas
- foreign exchange earnings
- per capita dietary energy supplies
- per capita national incomes
- income distribution
- life expectancy
- mortality rates
- school enrollment rates
- labor force participation rates
- urbanization rates
- conflict prevalences
- degree of democracy
- infrastructure index
- population size
- age distribution of the population

Where the goal is to estimate a developing-world prevalence, the region of location would also be included as a regressor.

The following is the estimating equation for the extrapolations:

$$\log\left(\frac{U_i}{1-U_i}\right)=\sum_{k=1}^{K}\beta_k X_{ik}+u_i \quad i=1,\ldots,m.$$

The X_k are regressors, the β_k are parameters to be estimated, and u is a stochastic error term. The logit transformation is used to restrict the predicted values to lie within the theoretical bounds (0,1) and to assure that the error term is unbounded (Ravallion, Datt, and van de Walle 1991).

Method 2: Extrapolations Based on Country-Specific Nonparametric Density Functions and Cross-Country Regression

This method[60] relies on the estimation of empirical household energy availability probability density functions, $f_i(x)$, for the countries for which survey data exist to predict density functions for the remaining $N-(m+1)$ countries. The method is nonparametric. Rather than requiring an a priori specification of a particular function form, the nonparametric approach is fully flexible. It allows the data to select the most appropriate representation of the distribution (Goodwin and Ker 1998; DiNardo and Tobias 2001). The estimation takes place in two stages.

In the first stage, the populations of countries C_1 through C_m are divided into D groups, indexed $d=1,\ldots,D,$ based on equal-sized energy availability intervals. Following, γ_{di}, the proportion of the countries' populations falling into each group, are estimated from the survey data. D cross-country regressions are then undertaken (corresponding to the D energy availability groups) in which the dependent variable is γ_{di} and the predicting variables used in Method 1 are the candidate regressors. The resulting estimating equations are then used to predict γ_{di}, $i=m+1,\ldots,N.$

The set of D estimating equations is as follows:

$$\log\left(\frac{\gamma_{1i}}{1-\gamma_{1i}}\right)=\sum_{k=1}^{K}\beta_{1k} X_{ki}+u_{1i} \quad i=1,\ldots,m.$$

$$\log\left(\frac{\gamma_{2i}}{1-\gamma_{2i}}\right)=\sum_{k=1}^{K}\beta_{2k} X_{ki}+u_{2i} \quad i=1,\ldots,m.$$

$$\log\left(\frac{\gamma_{Di}}{1-\gamma_{Di}}\right)=\sum_{k=1}^{K}\beta_{Dk} X_{ki}+u_{Di} \quad i=1,\ldots,m.$$

In the second stage, a nonparametric density estimation technique is employed to trace out $f_i(x)$ for the $N-(m+1)$ countries for which survey data do not exist using their predicted γ_{di}. The specific technique employed is the kernel method of smoothing to build continuous density functions. Here each country's observations are surrounded by a symmetric weighting function K satisfying the condition,[61]

$$\int_{-\infty}^{\infty}K(t)\,dt=1.$$

Let x_d represent the mean energy availability level of interval d. The kernel estimator of the probability density function of x is given by

$$\frac{1}{Dh}\sum_{d=1}^{D}K\left(\frac{x-x_d}{h}\right)$$

where h is a bandwidth parameter that controls the amount of smoothing. The proportion of each country's population acquiring less than z calories can then be estimated numerically.

[60] This method is founded on a discussion with Martin Ravallion of the World Bank.

[61] The weighting function $K(t)$ is normally a symmetric probability density function (Goodwin and Ker 1998).

APPENDIX F

Differences in Food Security Measures across Total Expenditure Quintiles when Quintiles Are Not Based on Predicted Expenditures

Table F.1 Differences in food security measures across total expenditure quintiles when quintiles are not based on predicted expenditures

	Food energy availability		Diet quality	
Expenditure quintile	Energy availability per capita	Percentage people food energy deficient	Household diet quality	Percentage of households with low quality diet
Burundi (1998)				
Quintile 1	688	99.4	3.7	56.9
2	1,396	89.1	4.4	37.1
3	2,153	53.7	4.8	28.4
4	3,100	21.4	5.1	18.3
5	4,055	9.0	6.1	8.4
Ethiopia (1999)				
Quintile 1	1,190	97.7	4.3	50.8
2	1,637	80.3	4.8	32.6
3	1,930	60.0	5.0	22.7
4	2,119	50.4	5.3	14.8
5	2,146	57.8	5.7	5.4
Ghana (1998)				
Quintile 1	1,435	81.5	5.3	12.4
2	2,023	59.8	5.7	6.3
3	2,480	42.3	5.9	7.1
4	3,011	28.4	6.1	4.8
5	3,607	18.3	6.1	12.7
Guinea (1994)				
Quintile 1	1,769	67.3	5.4	16.5
2	2,767	31.8	6.1	4.6
3	3,095	31.5	6.3	4.3
4	2,927	36.0	6.6	3.7
5	3,309	24.9	6.5	13.4

Table F.1—Continued

	Food energy availability		Diet quality	
Expenditure quintile	Energy availability per capita	Percentage people food energy deficient	Household diet quality	Percentage of households with low quality diet
Kenya (1997)				
Quintile 1	1,365	86.6	4.3	44.4
2	2,076	52.4	5.1	25.3
3	2,686	28.1	5.5	21.5
4	3,389	16.2	5.8	16.8
5	4,470	10.0	6.0	16.3
Malawi (1997)				
Quintile 1	1,109	95.4	3.9	80.8
2	1,521	81.6	4.1	73.0
3	1,864	67.4	4.3	69.0
4	2,114	61.5	4.5	61.3
5	2,052	65.5	5.3	34.5
Mozambique (1996)				
Quintile 1	980	93.8	3.7	92.7
2	1,720	70.2	4.0	91.5
3	2,270	47.7	4.2	83.5
4	2,879	31.5	4.4	73.4
5	4,004	16.7	5.1	47.8
Rwanda (2000)				
Quintile 1	852	97.9	3.6	70.8
2	1,457	84.9	4.2	51.0
3	1,965	60.8	4.5	38.9
4	2,555	36.1	4.9	28.7
5	3,107	25.4	5.8	15.7
Senegal (2001)				
Quintile 1	1,437	78.8	5.5	10.4
2	1,908	60.0	5.8	6.0
3	2,113	55.7	6.1	5.5
4	2,322	49.4	6.2	3.7
5	2,660	36.8	6.1	10.5
Tanzania (2000)				
Quintile 1	1,723	68.8	5.5	31.3
2	2,501	35.5	5.9	18.4
3	2,928	26.7	6.1	12.5
4	3,280	20.1	6.2	10.1
5	4,072	11.6	6.2	8.5
Uganda (1999)				
Quintile 1	1,732	67.4	3.7	73.9
2	2,497	35.4	4.1	58.0
3	2,892	23.3	4.5	46.8
4	3,307	21.1	4.7	42.0
5	3,505	16.3	5.3	26.3
Zambia (1996)				
Quintile 1	1,151	89.8	3.6	69.7
2	1,697	73.7	4.3	47.8
3	1,881	67.7	4.8	33.2
4	2,228	57.8	5.3	22.4
5	2,802	36.9	5.7	16.1

Note: All values are corrected for survey sampling designs.

References

ACC/SCN (Administrative Committee on Coordination/Subcommittee on Nutrition of the United Nations). 2000. *Fourth report on the world nutrition situation: Nutrition throughout the life cycle.* Geneva: United Nations.

———. 2004. *Fifth report on the world nutrition situation: Nutrition for improved development outcomes.* Geneva: United Nations.

Aduayom, D., and L. C. Smith. 2003. Estimating undernourishment with household expenditure surveys: A comparison of methods using data from three Sub-Saharan African countries. In *Measurement and assessment of food deprivation and undernutrition,* 241–244. Rome: FAO.

Agren, G., and R. Gibson. 1968. Food composition table for use in Ethiopia I. Stockholm: Swedish International Development Authority, Addis Ababa: Ethiopian Nutrition Institute.

Alderman, H., M. Babita, G. Demombynes, N. Makhatha, and B. Ozler. 2002. How low can you go? Combining census and survey data for mapping poverty in South Africa. *Journal of African Economies* 11 (2): 169–200.

Arbia, G. 2003. The effect of sampling design on the reliability of estimates of the variance of distributions derived from household survey data: A simulation study. In *Measurement and assessment of food deprivation and undernutrition,* 249–250. Rome: FAO.

Arimond, M., and M. T. Ruel. 2004. *Dietary diversity, dietary quality, and child nutritional status: Evidence from eleven demographic and health surveys.* Report submitted to the Food and Nutrition Technical Assistance Project, Academy for Educational Development. Washington, D.C.: International Food Policy Research Institute.

Arndt, C., H. T. Jensen, and F. Tarp. 2000. Stabilization and structural adjustment in Mozambique: An appraisal. *Journal of International Development* 12 (3): 299–323.

Becker, W. 2001. Comparability of household and individual food consumption data—evidence from Sweden. *Public Health Nutrition* 4: 1173–1176.

Behrman, J. R., and J. C. Knowles. 1997. *How strongly is schooling associated with household income?* PIER Working Paper No. 97-022. Penn Institute for Economic Research. Philadelphia: University of Pennsylvania.

Blades, D. W. 1980. What do we know about levels and growth of output in developing countries? A critical analysis with special reference to Africa. In *Economic growth and resources,* vol. 2: *Trends and flows,* ed. R. C. Matthews, 60–77. London: Macmillan.

Bouis, H. 1994. The effect of income on demand for food in poor countries: are our food consumption databases giving us reliable estimates? *Journal of Development Economics* 44: 19–226.

Bouis, H., and L. Haddad. 1992. Are estimates of calorie-income elasticities too high? A recalibration of the plausible range. *Journal of Development Economics* 39: 333–364.

Bouis, H., L. Haddad, and E. Kennedy. 1992. Does it matter how we survey demand for food? Evidence from Kenya and the Philippines. *Food Policy* 17 (5): 349–360.

Bouis, H., B. de la Briere, L. Buitierrez, K. Hallman, N. Hassan, O. Hels, W. Quabili, A. Quisumbing, S. Thilsted, Z. Hassan Zihad, and S. Zohir. 1998. Commercial vegetable and polyculture fish production in Bangladesh: their impacts on income, household resource allocation, and nutrition. Washington, D.C.: International Food Policy Research Institute.

Broca, S. 2003. Discussion group report—FAO method. In *Measurement and assessment of food deprivation and undernutrition,* 53–55. Rome: FAO.

Caldwell, R., M. Seroussi, C. Hagens, J. Huddle, C. Mbizule, and K. Uny. 2003. Malawi baseline survey: Report of findings. Prepared for C-SAFE. Tucson, Ariz., U.S.A.: TANGO International. http://www.c-safe.org/downloads/Mal-baseline%20Fin-Report.doc.

China (People's Republic of). 1992. Food consumption data from the urban and rural household surveys in China, 1985 and 1990. Prepared by the State Statistical Bureau, People's Republic of China, in collaboration with the Statistical Analysis Service, Statistics Division, Economic and Social Policy Department, FAO. Rome: FAO.

David, I. P. 2003. Discussion opener—FAO method. In *Measurement and assessment of food deprivation and undernutrition,* 43–47. Rome: FAO.

Deaton, A. 1997. *The analysis of household surveys: A microeconometric approach to development policy.* Baltimore, Md., U.S.A.: Johns Hopkins University Press for the World Bank.

———. 2003. How to monitor poverty for the millennium development goals. *Journal of Human Resources* 4 (3): 353–378.

Deaton, A., and M. Grosh. 2000. Consumption. In *Designing household survey questionnaires for developing countries: Lessons from 15 years of the Living Standards Measurement Surveys,* ed. M. Grosh and P. Glewwe, 91–133. Washington, D.C.: World Bank.

DiNardo, J., and J. L. Tobias. 2001. Nonparametric density and regression estimation. *Journal of Economic Perspectives* 15 (4): 11–28.

Dowler, E., and Y. Ok Seo. 1985. Assessment of energy intake: Estimates of food supply vs. measurement of food consumption. *Food Policy* 10 (August): 278–288.

ENI (Ethiopian Nutrition Institute). 1968. Expanded food composition table for use in Ethiopia. Addis Ababa.

Eyeson, K. K., and E. K. Ankrah. 1975. *Composition of foods commonly used in Ghana.* Food Research Institute (CSIR) and United Nations Development Programme (UNDP) and the Food and Agriculture Organization of the United Nations (FAO). Accra, Ghana: Food Research Institute.

FAO (Food and Agriculture Organization of the United Nations). 1983. *A comparative study of food consumption data from food balance sheets and household surveys.* Statistics Division, Economic and Social Development Paper 34. Rome: FAO.

———. 1996. *Sixth world food survey.* Rome: FAO.

———. 1999. Special report: FAO/WFP Crop and Food Supply Assessment Mission to Tanzania. Rome: FAO.

———. 2001. *The state of food insecurity in the world 2001.* Rome: FAO.

———. 2003. FAOSTAT database. http://apps.fao.org.

———. 2004a. Improvements in the estimation of the prevalence of undernourishment. Powerpoint presentation given at the Workshop on Measurement of Food Deprivation, October 22, Rome. http://www.fao.org/es/ESS/meetings/mofd_2004.asp.

———. 2004b. Women and food security. Rome: FAO. http://www.fao.org/FOCUS/E/Women/Sustin-e.htm.

———. 2005a. FAOSTAT. Food security statistics: Food needs. http://ww.fao.org/faostat/foodsecurity/Files/MinimumDietaryEnergyRequirement.xls.

———. 2005b. FAOSTAT. Food security statistics: Access to food. http://ww.fao.org/faostat/foodsecurity/Files/AccessToFoodGini.xls.

FAO/WHO/UNU (Food and Agriculture Organization of the United Nations/World Health Organization/United Nations University). 1985. Protein and energy requirements. Rome: FAO.

Ferro-Luzzi, A. 2003. Individual food intake survey methods. In *Measurement and assessment of food deprivation and undernutrition,* 101–126. Rome: FAO.

FEWS NET. 1997. The uneven Ugandan recovery. December 27, 1997. USAID Famine Early Warning Systems Network. http://www.fews.net.

Filmer, D., and L. Pritchett. 1998. *Estimating wealth effects without expenditure data—or tears: with an application to educational enrollments in states of India.* World Bank Policy Research Working Paper No. 1994. Washington, D.C.: World Bank.

Frankenberger, T. R., L. Frankel, S. Ross, M. Burke, C. Cardenas, D. Clark, A. Goddard, K. Henry, M. Middleberg, D. O'Brien, C. Perez, R. Robinson, and J. Zielinski. 1997. Household livelihood security: A unifying conceptual framework for CARE programs. In *Proceedings of the USAID workshop on performance measurement for food security,* Arlington, Va., U.S.A., December 11–12, 1995. Washington, D.C.: U.S. Agency for International Development.

Frankenberger, T., K. Luther, K. Fox, and J. Mazzeo. 2003. *Livelihood erosion through time: Macro and micro factors that influenced livelihood trends in Malawi over the last 30 years.* For CARE Southern and Western Africa Regional Management Unit (SWARMU). Tucson, Ariz., U.S.A.: TANGO International.

Friel, S., M. Nelson, K. McCormack, C. Kelleher, and P. L. Thriskos. 2001. Methodological issues using household budget survey expenditure data for individual food availability estimation: Irish experience in the DAFNE pan-European project. *Public Health Nutrition* 4 (5B): 1143–1148.

FSANZ (Food Standards Australia New Zealand). 2004. Explanatory notes for use with the on-line nutrition panel calculator (NPC). Supported by AUSNUT Special Edition (3) (Australian Food and Nutrient Database for Nutrition Labelling, Release 3). Commonwealth of Australia and Food Standards Australia New Zealand. http://www.foodstandards.gov.au/_srcfiles/Explanatory_notes_for_the_NPC_coldfusion_October_2004_final.pdf.

Gabbert, S., and H. P. Weikard. 2001. How widespread is undernourishment? A critique of measurement methods and new empirical results. *Food Policy* 26 (3): 209–228.

Garrett, J. 1998. Food and nutrition security in Mozambique: Characteristics, determinants, and strategic insights. In *Understanding poverty and well-being in Mozambique: the first national assessment (1996–97).* Chapter 4, pp. 203–267. Washington, D.C.: MPF/UEM/IFPRI.

Gillen, E. D. 2004. *Food consumption estimates; data sources, problems, and limitations; improvements.* Powerpoint presentation given at the Workshop on Measurement of Food Deprivation, October 22, 2004. Rome: FAO. http://www.fao.org/es/ESS/meetings/mofd_2004.asp.

Gladwin, C., and A. Thomson. 2004. *Food or cash crops? Which is the key to food security?* Prepared for the University of Florida's Gender and Soil Fertility in Africa web page (http://www.fred.ifas.ufl.edu/CRSP/food.htm). Gainesville, Fla., U.S.A.: University of Florida.

Goodwin, B. K., and A. P. Ker. 1998. Nonparametric estimation of crop yield distributions: Implications for rating group-risk crop insurance contracts. *American Journal of Agricultural Economics* 80 (1): 139–153.

Government of Tanzania. 2000. *Rapid assessment report on crop and food supply situation in Tanzania for the 1999/2000 agricultural season.* Coordinated by the Disaster Management Department of the Office of the Prime Minister and the Food Security Department of the Ministry of Agriculture and Cooperatives, Dar es Salaam. July 25, 2000.

Graham, R., R. M. Welch, and H. E. Bouis. 2004. *Addressing micronutrient malnutrition through enhancing the nutritional quality of staple foods: Principles, perspectives and knowledge gaps.* Department of Plant Science, University of Adelaide; U.S. Plant, Soil and Nutrition Laboratory, USDA-ARS, Ithaca, N.Y.; International Food Policy Research Institute, Washington, D.C. http://www.css.cornell.edu/FoodSystems/AdvAgron4.html.

Green, W. H. 1997. *Econometric Analysis.* 3d ed. Upper Saddle River, N.J., U.S.A.: Prentice Hall.

Haddad, L. 2001. *DfID-funded technical support facility to FAO's FIVIMS.* Technical Paper 1. *Deepening the analysis of the factors behind progress towards WFS targets.* Report submitted to Overseas Development Institute. Washington, D.C.: International Food Policy Research Institute.

Haddad, L., and R. Kanbur. 1990. How serious is the neglect of intrahousehold inequality? *Economic Journal* 100 (402): 866–881.

Haddad, L., J. Hoddinott, and H. Alderman, eds. 1997. *Intrahousehold resource allocation in developing countries: Models, methods, and policy.* Baltimore, Md., U.S.A., and London: Johns Hopkins University Press for the International Food Policy Research Institute.

Higgins, P. A., and H. Alderman. 1997. Labor and women's nutrition: The impact of work effort and fertility on nutritional status in Ghana. *Journal of Human Resources* 32 (3): 577–595.

Hoddinott, J., ed. 2001. *Food security in practice: Methods for rural development projects.* Washington, D.C.: International Food Policy Research Institute.

ICN (International Conference on Nutrition). 1992. *Caring for the socioeconomically deprived and nutritionally vulnerable.* Major Issues for Nutrition Strategies Theme Paper No 3. ICN/92/INF/7. Rome: FAO and World Health Organization.

IFPRI (International Food Policy Research Institute). 1998. *2020 Vision Network for West Africa: Country Note for Senegal.* Accra, Ghana: IFPRI.

Kennedy, E. 2003. Qualitative measures of food insecurity and hunger. In *Measurement and assessment of food deprivation and undernutrition,* 165–180. Rome: FAO.

Lagiou, P., A. Trichopoulou, and the DAFNE contributors. 2001. The DAFNE initiative: The methodology for assessing dietary patterns across Europe using household budget survey data. *Public Health Nutrition* 4: 1135–1142.

Landis, J. R., and G. G. Koch. 1977. The measurement of observer agreement for categorical data. *Biometrics* 33 (1): 159–174.

Latham, M. C. 1997. *Human nutrition in the developing world.* Food and Nutrition Series No. 29. Rome: FAO. http://www.fao.org/DOCREP/W0073e/w0073e00.htm.

Lence, S. 2003. Discussion opener—Household expenditure survey methods. In *Measurement and assessment of food deprivation and undernutrition.* Rome: FAO.

Leung, W.-T. W. 1968. *Food composition table for use in Africa.* Rome: FAO, and Bethesda, Md., U.S.A.: U.S. Department of Health, Education, and Welfare.

Mason, J. 2003. Measuring hunger and malnutrition. In *Measurement and assessment of food deprivation and undernutrition,* 197–228. Rome: FAO.

Maxwell, S., and T. R. Frankenberger. 1992. *Household food security: Concepts, indicators, measurements: A technical review.* New York and Rome: United Nations Children's Fund and International Fund for Agricultural Development.

Maxwell, D. G., A. Clement, C. E. Levin, M. Armar-Klemesu, S. Zakariah, and G. M. Lamptey. 1999. Alternative food-security indicators: Revisiting the frequency and severity of "coping strategies." *Food Policy* 24 (4): 411–429.

Mozambique. 1991. *Tabela de Composição de Alimentos.* Maputo, Mozambique: Ministry of Health, Nutrition Section.

Naiken, L. 2003. FAO methodology for estimating the prevalence of undernourishment. In *Measurement and assessment of food deprivation and undernutrition,* 7–42. Rome: FAO.

Naska, A., S. Paterakis, H. Eeckman, A. M. Remaut, and K. Trygg. 2001. Methodology for rendering household budget and individual nutrition surveys comparable, at the level of the dietary information collected. *Public Health Nutrition* 4: 1153–1158.

Naska, A., V. G. S. Vasdekis, and A. Trichopoulou. 2001. A preliminary assessment of the use of household budget survey data for the prediction of individual food consumption. *Public Health Nutrition* 4: 1159–1166.

NBST (National Bureau of Statistics of Tanzania). 2002. *Household Budget Survey 2000/01.* Dar es Salaam: NBST.

Ndaiye, A. M. 1993. *Aliments Africains: Table de composition.* Dakar, Senegal: Organisme de Recherches sur l'Alimentation et la Nutrition Africaines (ORANA).

Ndaiye, A. 2003. *Child malnutrition in Niger: An investigation of patterns of change.* M.A. thesis, Department of Agricultural and Resource Economics, University of Arizona, Tucson, Ariz., U.S.A.

Nordeide, M. B. 2003. *The composition of Malian foods.* Bamako, Mali: CNRST, Programme de Recherche SSE, and Oslo, Norway: Nordic School of Nutrition, University of Oslo.

Nyanteng, V. K., and S. Asuming-Brempong. 2003. *The role of agriculture in food security in Ghana.* Paper prepared for the Role of Agriculture International Conference, Rome, October 20–22. Rome: FAO.

Oguntona, E. B., and I. O. Akinyele, eds. 1995. *Nutrient composition of commonly eaten foods in Nigeria—Raw, processed and prepared.* Food Basket Foundation Publication Series. Ibadan, Nigeria: Food Basket Foundation International.

Pellet, P. L., and S. Shadarevian. 1970. *Tables for use in the Middle East,* 2d ed. Beirut, Lebanon: American University of Beirut.

Platt, B. S. 1962. *Tables of representative values of foods commonly used in tropical countries.* London: Medical Research Council. (Reprinted 1985 by the London School of Hygiene and Tropical Medicine, Department of Human Nutrition, by permission of the Controller of Her Majesty's Stationery Office.)

Quisumbing, A., L. Haddad, and C. Peña. 2001. Are women overrepresented among the poor? An analysis of poverty in ten developing countries. *Journal of Development Economics* 66 (1): 225–269.

Ravallion, M. 2001. *Measuring aggregate welfare in developing countries: How well do national accounts and surveys agree?* Washington, D.C.: World Bank.

Ravallion, M., G. Datt, and D. van de Walle. 1991. Quantifying absolute poverty in the developing world. *Review of Income and Wealth* 37 (4): 345–361.

Resnick, D. 2004. *Smallholder African agriculture progress and problems in confronting hunger and poverty.* Development Strategy and Governance Division Discussion Paper 9. Washington, D.C.: International Food Policy and Research Institute.

Rimmer, D. J. 2001. An overview of food eaten outside the home in the United Kingdom National Food Survey and the new Expenditure and Food Survey. *Public Health Nutrition* 4: 1173–1176.

Ruel, M. T. 2002. *Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs.* Food Consumption and Nutrition Division Discussion Paper 140. Washington, D.C.: International Food Policy Research Institute.

Ruel, M. T. 2003. Operationalizing diet diversity: A review of measurement issues and research priorities. *Journal of Nutrition* 133 (11): 3911S–3926S.

Ruel, M., and J. Garrett. 2004. Features of urban food and nutrition security and considerations for successful urban programming. *Electronic Journal of Agricultural and Development Economics* 1 (2). http://www.fao.org/es/esa/en/ejade.htm.

Ruel, M. T., L. Haddad, M. Arimond, D. Gilligan, N. Minot, K. Simler, and X. Zhang. 2003. Diet quality and diet changes of the poor: A global research program to improve dietary quality, health, and nutrition. A proposal for a global research program (GRP24). Washington, D.C.: International Food Policy Research Institute.

Ruel, M. T., J. M. Graham, S. Murphy, and L. H. Allen. 2004. *Simple dietary diversity indicators predict nutrient adequacy in school-age Kenyan children.* Report submitted to GL-CRSP. Washington, D.C.: IFPRI.

Sachs, J. 2004. Doing the sums on Africa. *Economist* May 20, 2004, 19–21.

Sehmi, J. K. 1993. *National food composition tables and the planning of satisfactory diets in Kenya.* Nairobi: Ministry of Health, Government of Kenya.

Senauer, B. 2003. FAO methodology for estimating the prevalence of undernourishment. Discussion opener. In *Measurement and assessment of food deprivation and undernutrition,* 49–52. Rome: FAO.

Senauer, B., and M. Sur. 2001. Ending global hunger in the 21st century: Projections of the number of food insecure people. *Review of Agricultural Economics* 25 (spring/summer): 68–81.

Shapouri, S., and S. Rosen. 1999. *Food security assessment: Why countries are at risk.* Agricultural Information Bulletin No. 754. Washington, D.C.: Economic Research Service, United States Department of Agriculture.

Shetty, P. 2003. Measures of nutritional status from anthropometric survey data. In *Measurement and assessment of food deprivation and undernutrition,* 139–154. Rome: FAO.

Smith, L. C. 1998a. Can FAO's measure of chronic undernourishment be strengthened? *Food Policy* 23 (4): 425–445.

———. 1998b. *Can FAO's measure of undernourishment be strengthened?* With a response by L. Naiken. Food Consumption and Nutrition Division Discussion Paper 44. Washington, D.C.: International Food Policy Research Institute.

———. 2003. The use of household expenditure surveys for the assessment of food insecurity. In *Measurement and assessment of food deprivation and undernutrition,* 57–88. Rome: FAO.

Smith, L., A. El Obeid, H. Jensen, and S. R. Johnson. 1999. The geography and causes of food insecurity in developing countries. Chapter 5 in *Food security: New solutions for the 21st century,* ed. A. El Obeid, S. R. Johnson, H. Jensen, and L. Smith. Ames, Iowa, U.S.A.: Iowa State University Press.

Srivastava, A. K., A. Rai, and V. Ramasubramanian. 2003. On reliability of estimates of inequality in distributions derived from sample survey data. In *Measurement and assessment of food deprivation and undernutrition,* 245–248. Rome: FAO.

StataCorp. 2003. *Stata 8 Reference Manual.* College Station, Tex., U.S.A.: Stata Corporation.

Statsoft. 2005. Nonparametric statistics. Electronic Statistics Textbook. Tulsa, Okla.: Statsoft. http://www.statsoftinc.com/textbook/stnonpar.html.

Svedberg, P. 1999. 841 million undernourished? *World Development* 27 (12): 2081–2098.

———. 2000. *Poverty and undernutrition: Theory, measurement, and policy.* Oxford: Oxford University Press.

———. 2003. Fallacies in—and ways of improving—the FAO methodology for estimating prevalence of undernutrition. In *Measurement and assessment of food deprivation and undernutrition,* 235–236. Proceedings of an International Scientific Symposium. Rome: FAO.

Swindale, A., and P. Ohri-Vachaspati. 2004. Measuring household food consumption: A technical guide. Washington, D.C.: Food and Nutrition Technical Assistance (FANTA) Project and Academy for Educational Development (AED).

Tanzania. 2000. *Rapid assessment report on crop and food supply situation in Tanzania for the 1999/2000 agricultural season.* Coordinated by the Disaster Management Department of the Office of the Prime Minister and the Food Security Department of the Ministry of Agriculture and Cooperatives, Dar es Salaam.

Trochim, W. M. 2001. *The research methods knowledge base,* 2nd ed. http://trochim.human.cornell.edu/kb/index.htm (version current as of 2001).

UNDHA (United Nations Department of Humanitarian Affairs). 1996. Great Lakes: IRIN Food Security Overview Paper. 12/23/96. New York: Integrated Regional Information Network (IRIN), UNDHA.

UNICEF (United Nations Children's Fund). 1998. *The state of the world's children 1998.* New York: Oxford University Press.

USDA (United States Department of Agriculture). 1963. *Composition of foods.* Washington, D.C.: USDA.

———. 1998. *Composition of foods commonly eaten. Data files.* Washington, D.C.: USDA.

———. 1999. *USDA nutrient database for standard reference,* release 13. Washington, D.C.: USDA.

———. 2002. *USDA nutrient database for standard reference,* release 15. Washington, D.C.: USDA.

——— 2003. *Composition of foods, raw, processed, prepared. USDA nutrient database for standard reference,* release 15. Beltsville, Md., U.S.A.: USDA Agricultural Research Service.

U.S. Department of State. 2004. *Background note Guinea. April.* Washington, D.C.: Bureau of African Affairs.

USDHEW/FAO (United States Department of Health, Education, and Welfare/Food and Agriculture Organization of the United Nations). 1968. *Food composition table for use in Africa.* Bethesda, Md., U.S.A.: USDA, and Rome: FAO.

Vasdekis, B. G. S., S. Stylianou, and A. Naska. 2001. Estimation of age- and gender-specific food availability from household budget survey data. *Public Health Nutrition* 4 (5B): 1149–1152.

Welch, R. 2004. Micronutrients, agriculture, and nutrition: Linkages for improved health and well being. USDA-ARS, U.S. Plant, Soil and Nutrition Laboratory, Ithaca, N.Y. http://www.css.cornell.edu/FoodSystems/Micros%26AgriMan1ref.html.

West, C. E., F. Pepping, I. Scholte, W. Jansen, and H. F. F. Albers. 1987. *Food composition table for energy and eight important nutrients in foods commonly eaten in East Africa* (Poster). Wageningen, The Netherlands: Technical Centre for Agriculture and Rural Cooperation (CTA) of ACP/ECP Convention of Lome, and Food and Nutrition Cooperation (ECSA), Department of Human Nutrition, Wageningen Agricultural University, and Dar es Salaam, Tanzania: Tanzania Food and Nutrition Centre.

West, C. E., F. Pepping, and C. R. Temalilwa, eds. 1988. *The composition of foods commonly eaten in East Africa.* Wageningen, The Netherlands: Wageningen Agricultural University.

WHO (World Health Organization). 2003. *WHO Global database on child growth and malnutrition.* Geneva: WHO.

Williamson, J. 1975. *Useful plants of Malawi,* rev. ed. Limbe: Montfrort.

Wobst, P. 2001. *Structural adjustment and intersectoral shifts in Tanzania.* Research Report 117. Washington, D.C.: International Food Policy Research Institute.

World Bank. 2003. *2003 world development indicators.* Washington, D.C.: World Bank.

———. 2004. *Country brief, Burundi, history.* http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/ BURUNDIEXTN.

Zhang, X., M. Johnson, D. Resnick, and S. Robinson. 2004. *Cross-country typologies and development strategies to end hunger in Africa.* Development Strategy and Governance Division Discussion Paper 8. Washington, D.C.: International Food Policy Research Institute.